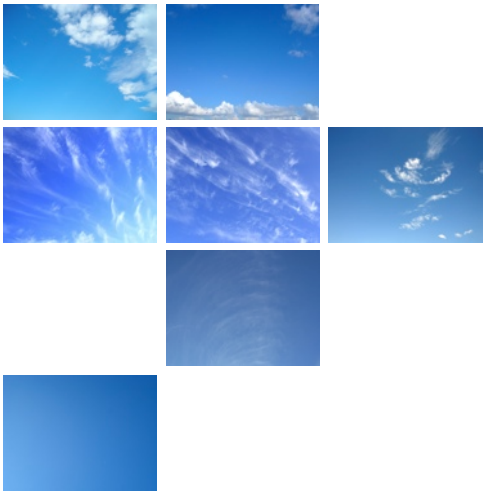

Quantifying a Relationship Between Place-based Learning and Environmental Quality

Final Report

Quantifying a Relationship Between
Place-based Learning and Environmental Quality
Final Report

A Technical Assistance Report

Prepared by
National Park Service Conservation Study Institute

In Collaboration with Shelburne Farms under Cooperative Agreement #H1818-07-0001,
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for

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Foreword

by Ginger Potter, United States Environmental Protection Agency

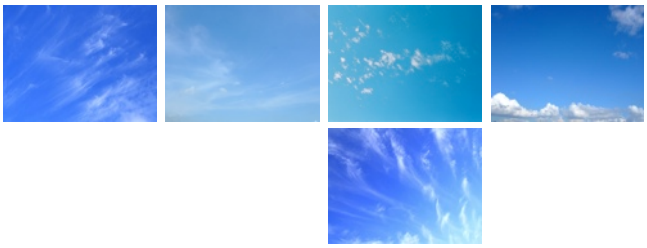
Since its creation in 1970, the U.S. Environmental Protection Agency has made enormous progress in improving the quality and quantity of our country's natural resources through its mission to protect human health and the environment. Regulation and enforcement were, and still remain, the primary tools EPA uses to mitigate the damage to the environment caused by the most highly visible forms of "point-source" pollution from our chemical, plastics, petroleum, automotive and aviation industries, among others.

However, many believe that we have reached the limit of what this type of approach can achieve in terms of improved environmental quality. In addition, research now shows that the primary sources of pollution in this country are diffuse "non-point source" pollution generated by the individual, the household and small and medium sized industries, businesses and farms that are difficult and expensive to regulate. We must now look towards supplementing regulations with other tools for environmental protection such as education, information, and voluntary compliance programs.

It is important to show that environmental education programs lead to improvements in environmental quality.

The complexity of environmental problems continues to increase and will require a citizenry that is environmentally literate and committed to taking personal responsibility for protecting the environment. EPA's Office of Environmental Education believes that education is essential to increasing environmental literacy and promoting stewardship and environmentally friendly behaviors. And there is increasing evidence to show that environmental education programs and practices lead to improvements in academic achievement and environmental attitudes. However, it is also important to show that environmental education programs also lead to improvements in environmental quality.

Until now, research that focuses on the impacts of environmental education on environmental quality has been extremely limited. It is methodologically challenging and requires sustained resources. Nevertheless, with the increasing focus on climate change, global warming, and biodiversity and wetlands loss, it is imperative that we commit to research that explores the use of education programs to address these and other complex environmental issues. This study of the impact of place-based learning programs on air quality at the local community level is an important step in evaluating how environmental education programs can and do lead to improved environmental quality. We hope that this study will launch a larger and broader effort to investigate and quantify the important outcomes of environmental education programs on environmental quality.



Foreword

by Nora Mitchell, Director, National Park Service Conservation Study Institute

This study represents an important step forward in our understanding of how place-based learning can improve environmental quality. While this research emphasizes education programs focused on air quality, the study findings have direct implications for other environmental areas and are of great value to public land managers as they develop and improve their education programs. This research also illustrates the value of place-based learning in opening doors to partnerships between public lands and their neighboring communities. Working collaboratively, public land managers, communities, and schools can create educational experiences that improve environmental quality and engage the next generation of stewards.

Working with Ginger Potter and the Environmental Protection Agency on this project illustrates our shared interests and the opportunities offered through interagency collaboration linking education, environmental quality, and public lands. This project capitalizes on the ten-year public-private partnership between the National Park Service Conservation Study Institute and Shelburne Farms. The Institute-Shelburne Farms partnership has worked to identify, demonstrate, and share promising practices to a broad audience of public land managers, teachers and school groups, and non-profit organizations. For this project, Shelburne Farms fielded an exceptional team and we greatly appreciate their ability to combine practical experience with scientific rigor. We hope this report will encourage additional research and evaluation and will contribute to the effectiveness and benefits of place-based education.

Information about the Conservation Study Institute and Shelburne Farms and their programs is available online at www.nps.gov/csi and www.shelburnefarms.org.

Executive Summary

Can education programs improve the environment? According to the National Environmental Education Advisory Council (2005), this is one of the most important questions facing the field of environmental education as it matures and responds to challenges from critics and supporters alike. This study was aimed directly at addressing this question. Our goal was to investigate to what extent environmental improvement was a focus of school-based and nonformal education programs that focus on air quality (AQ), the degree to which such programs achieved measurable improvements, and whether specific instructional methods were associated with these improvements.

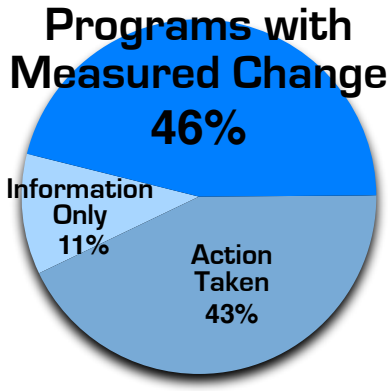
Over the course of 2007-2008, our multiagency evaluation group attempted to identify and contact all of the major air quality education programs in the United States. We completed a standardized telephone interview with representatives of 54 programs. Quantitative analysis of these interviews generated three key findings: 1) nearly half of the programs we studied reported evidence that air quality had actually improved over the course of their projects; 2) most of the programs we studied took some sort of action to improve air quality; and 3) programs reporting more place-based learning (PBL) qualities and practices such as service-learning and community partnerships were more likely to report improvements in air quality.

Nearly half of the programs we studied reported evidence that air quality had improved over the course of their projects.

A program at East Valley Middle School in Washington state exemplified one category of AQ improvements found in our study sample. Student investigations revealed unhealthy levels of CO_2, mold, odors, airflow, and airborne particulates in classrooms at their school. After working with school administrators and maintenance staff to address the problems, the students conducted post-measurements and found improvements in all indicators. Of the programs we studied, 11% reported positive changes in pre- and post- measures of *physical* air quality indicators similar to those at East Valley.

A different type of evidence of improved air quality was reported by a program at Exeter High School in New Hampshire. Based on data from their monitoring of school and car bus idling rates in the school parking lot, students successfully led an effort to enact a school-wide no-idling policy and to install no-idling signs on school grounds. While these students did not generate subsequent measures of the effects of reduced vehicle emissions on physical air quality, the resulting policy implementation was presumed to effectively improve AQ. The Exeter example demonstrates how education programs can improve *proxy* indicators of air quality, in this case car and bus idling rates. Such proxy indicators of improved air quality were reported by 35% of the programs in our sample.

Types of Outcomes of Air Quality Education Programs in This Study



Combining the two types of evidence (i.e. physical and proxy indicators), we found that nearly half (46%) of the programs in our study reported credible improvements in air quality associated with their educational efforts. Given the current dearth of literature linking education and environmental quality improvement, finding such a relatively high percentage of programs reporting this result was an exciting outcome.

Our findings provide evidence that education can be a viable approach for achieving measurable EQ improvements.

The vast majority (89%) of air quality education programs we studied were action oriented, even if they did not report direct improvements in AQ. Teenagers working with a community group in Oakland, CA, for example, wrote letters to local government officials and industry leaders, and participated in a press conference promoting air quality awareness. High school students in Darrington, WA, presented slide shows about air quality and trained local community groups how to access AQ monitoring information online. High school students in Berlin, VT, monitored AQ in their school yard and presented their findings and a no-idling policy proposal to the school board.

Analyzing the study sample as a whole, the single strongest predictor of air quality improvement was the degree to which the program incorporated an aggregate measure of the principles of place-based learning (r=.40, p<.01). This finding was significant even when controlling for funding, instructional dose, and background factors. The two most significant individual PBL qualities and practices that predicted air quality improvement outcomes were the inclusion of a service-learning component (r=.38, p<.01) and a connection to authentic needs of the local community (r=.33, p<.05).

The generalizability of our findings was limited to some extent by the relatively small and possibly nonrepresentative sample, by a potential confound between EQ improvement as a primary outcome measure and the extent of PBL practices, and by the risk of bias in self-report survey data

from program personnel. Additional studies involving larger and more systematically selected samples, the use of experimental or quasi-experimental designs, and in-depth case studies could further test our findings. Future studies could also replicate and refine our methods while investigating other environmental quality topics such as climate change, water quality, or biodiversity.

In sum, our findings provide preliminary evidence that education can be a viable approach for achieving measurable improvements in environmental quality. Policy makers may want to consider a new category of financial support for projects that actively attempt to improve environmental quality through education programs. Such programs may be able to deliver significant benefits at relatively low cost compared with other conservation strategies. Educators with an expressed goal of addressing environmental quality issues should consider adding pre- and post- indicator measurement components to their programs. Additionally, such educators should focus on specifically engaging participants in investigating and measuring real-world environmental quality issues in their local communities.

Quantifying a Relationship Between Place-based Learning and Environmental Quality

At a Glance

Key Findings

- *Nearly half (46%) of the programs studied reported evidence of improvements in air quality.*
- *Most (89%) of the programs studied took some form of action to promote air quality improvement.*
- *Programs reporting more place-based learning practices also showed more evidence of improved air quality ($r=.40$, $p<.01$).*

Policy Implications

- *Consider financial support for conservation projects that actively attempt to improve EQ through education programs.*
- *EQ education programs may provide a good return on investment.*
- *Promote discussion and measurement of EQ outcomes within the EE community.*

Practice Implications

- *Consider adding measurement and assessment components to EQ-related programs.*
- *Focus more on specific educational practices (especially active engagement in real-world EQ issues in local communities) and less on pedagogical labels (e.g. "Place-based," "Environmental," or "Service-learning").*

Background and Context

In its 2005 report to Congress on the status of environmental education[1] (EE) in the United States, the National Environmental Education Advisory Council called for increased research to assess EE's effectiveness in achieving environmental protection goals (National Environmental Education Advisory Council, 2005). In previous decades, EE research had grown and matured with documented impacts on student achievement and citizenship (Glenn, 2000; Lieberman & Hoody, 1998; North American Association for Environmental Education & National Environmental Education and Training Foundation, 2001; Rickinson, 2001), and investigation of the connection between knowledge, awareness, and behavior (Chawla & Cushing, 2007; Hungerford, Volk, & Ramsey, 2000; Jensen & Schnack, 1997; Leeming, Dwyer, & Porter, 1993; Zelezny, 1999). Despite this progress, questions remain regarding the field's effectiveness and abilities to achieve its goals (Palmer, 1999; Reid & Nikel, 2003; Reid & Scott, 2006). One area of recent concern is the capacity of EE to ultimately improve environmental quality (EQ) (Marcinkowski, Jickling, Potter, McKenzie, & Heimlich, 2008). Addressing this question may be critical if the field is to sustain high levels of public and governmental support over the long-term.

The question of EE's impact on environmental protection and environmental quality improvement is also relevant because of the important role public awareness and education play in developing an effective conservation strategy (Salafsky, Margoluis, Redford, & Robinson, 2002). The *Convention on Biological Diversity* (Secretariat of the Convention on Biological Diversity, 2005) and the *Global Strategy for Plant Conservation* (Secretariat of the Convention on Biological Diversity, 2002), which both include education-related goals and targets, are international ex-

[1] While this study was focused on the principles and practices of place-based learning (a relatively young field with many similarities to environmental education), EE is an older and more well-developed field. Thus, EE is the dominant focus of current literature and policy. It is beyond the scope of this study and this report to discuss fully the distinctions that can be made between PBL and EE. For the purposes of this study, we found it more useful to emphasize the broad similarities rather than the more specific differences, and therefore use the terms relatively interchangeably. This paper will refer to EE most often in the context of the research literature or policy, and will refer to PBL most often when discussing specific aspects of this study.

amples of the conservation community's recognition of the importance of EE. In the United States, the Environmental Protection Agency's Office of Environmental Education provides federal support for education that promotes conservation and environmental problem solving. EE and PBL represent particularly rich opportunities to achieve public participation in environmental decision-making, as education activities can be an important interface between governing bodies and individual citizens at the local level. Education can provide this link by acting as a translator of technical information into language that is relevant and accessible. An EE or PBL program is often an early point of entry for an individual's understanding of the complexity of ecological systems and participation in problem-solving efforts. But again the question remains: Can education play a significant role in improving environmental quality?

EE could be further legitimized by research that demonstrates a link between education and EQ improvements.

EE is now a requirement in certain state teacher certification processes (Plevyak, Bendixen-Noe, Henderson, Roth, & Wilke, 2001; Wilke, 1985), and research has shown widespread public support for EE (Glenn, 2000). Programs such as Project Wild and Project Wet have trained more than one million teachers (Carey & Harrison, 2007), and environmental curriculum packages focusing on a range of topics are widely available to educators at limited or no cost.

Most EE outcomes research, however, has focused on the role EE can play in improving school performance and inspiring environmental citizenship (Archie, 2003; Ernst & Monroe, 2004; Glenn, 2000; Lieberman & Hoody, 1998; National Education and Environment Partnership, 2001; North American Association for Environmental Education & National Environmental Education and Training Foundation, 2001; Rickinson, 2001; Schneider and Cheslock, 2003). While this initial body of evidence is increasingly compelling toward these ends, the field of EE could be broadened and further legitimized by empirical research that demonstrates a link between education and improvements in environmental quality.

"Place-based learning" approaches to EE are relatively common and by definition expand the focus of teaching beyond the classroom and outward to the surrounding place in which they are offered. We hypothesized that PBL programs would be among the most likely to focus on improved environmental quality and concentrated on PBL approaches to EE.

Our study was one of the first to directly investigate the relationship between PBL or EE programs and improvements in environmental quality. Previously, research-based evidence exploring the link between EE and direct measures of environmental quality had not been aggregated or synthesized to any significant degree. Our research therefore had four main objectives: 1) to gather environmental outcomes data from education programs that focused on air quality; 2) to quantitatively analyze those data as a dependent variable of PBL implementation; 3) to identify the common characteristics of programs that demonstrated the largest effects on air quality improvement; and 4) to develop a protocol for replicating this analysis with other areas of environmental concern such as water quality or climate change.

Findings of Related Research

Hungerford (2001) has suggested that one of the greatest myths of EE is that it actually improves environmental quality. Similarly, Fien, Scott, & Tilbury (2001) have said that "it would take a brave evaluator" (p. 387) to claim a causal link between EE and conservation or EQ impacts. A recent review of EE research literature, however, identified nearly two dozen studies in which an EQ improvement claim was made as a result of an EE program (Johnson, 2008). Although these cases were typically supported by little or no systematic evidence or details of this relationship, they nonetheless establish a history of investigation of the concept however preliminary. The literature review also suggests that EE programs might be more effective in impacting EQ proxy indicators (e.g. waste or energy reduction, EQ-related policy actions), rather than specific physical environmental indicators (e.g. air or water quality data).

Nearly two dozen previous studies have reported EQ improvements as a result of an EE program.

Short's (2007) work is the most ambitious project to date that has attempted to investigate the EE-EQ relationship. He explicitly recognizes the methodological challenges involved in evaluating EE programs for their EQ impacts and therefore proposes a tool for measuring the EQ impacts of student-led environmental actions that could overcome at least some of these challenges. His "Environmental Education Performance Indicator" (EEPI)—an adaptation of the Oslo-Potsdam Solution for International Environmental Regime Effectiveness—was applied to five case studies of schools utilizing the *Investigating and Evaluating Environmental Issues and Actions* curriculum (see Hungerford, Volk, Ramsey, Litherland, & Peyton, 2003). Short concluded that student-led environmental projects can result in improved EQ, and he suggested that his EEPI can provide a means for objectively evaluating EQ impacts, especially given that few EE programs have sufficient pre- and post-program environmental indicator data. What is perhaps most innovative about the EEPI tool is that it provides a means for esti-

mating quantitative EQ impacts, even in the absence of specific EQ data, and uses that estimate to arrive at a program effectiveness score comparable across programs with different delivery models and content areas.

Short (2007) acknowledges limitations to his model in its current form, including a small sample size, the limited time frame of EE programs evaluated, and minimal access to student participants. Additionally, Short's definition of environmental quality (and thus the criteria against which the programs were evaluated) is heavily focused on biodiversity indicators, potentially limiting its utility for projects addressing environmental health, urban sustainability, or more social environmental issues. Nevertheless, his attempt to standardize an evaluation process for the EE-EQ relationship is a noteworthy step forward and warrants further study.

A handful of other studies have attempted to investigate the EQ impacts of a specific education program. Dietz, Clausen, and Filchak (2004) used environmental indicator data to evaluate the impacts of a project in which homeowners were educated about the impact of lawn and driveway runoff on water quality. The authors concluded that reduced levels of nitrogen (down 75%) and bacteria concentrations in storm water runoff were "due to education" (Dietz et al., 2004, p. 689). In a similar effort to curtail storm water runoff pollution, Taylor, Curnow, Fletcher, and Lewis (2007) used a public and commercial education campaign to attempt to reduce litter in storm water runoff. The study concluded that the campaign "probably reduced litter loads" (Taylor et al., 2007, p. 332), but few of the effects on storm water quality achieved statistical significance.

Two other studies investigated EQ outcomes of waste reduction education programs (Armstrong, Sharpley, & Malcolm, 2004) and energy reduction education programs (Purnell, Sinclair, & Gralton, 2004) in Australia. In both studies, the programs achieved measurable changes in EQ *proxy indicators* (in this case, volume of waste to landfills and energy spending). The Australian case studies are more typical of EQ impact claims in the research literature in that they focus on proxy indicators of environmental improvement. Even though studies based on proxy indicators are still relatively limited in number, they illustrate the usefulness of the concept. In most cases where a proxy indicator improvement claim is made, however, the primary purpose of the studies was not to evaluate EE impacts on EQ but rather to examine other program outcomes (e.g. learning, awareness).

These examples from the research literature shed light on several reasons it is difficult for EE programs to result in measurable improvements in EQ. First of all, since many EE programs are school-based and spend only a few hours focused on very big problems, it may seem unrealistic to think that improving environmental quality could even be a legitimate area for evaluation. Second, most widely accepted goals of EE focus on the creation of an environmentally literate citizenry, which is related to but does not necessarily imply improvements in environmental quality as a direct measurable result. Finally, since changes in attitudes and behaviors as a result of EE programs are more likely to occur over the course of years or even a lifetime, measuring direct impacts longitudinally over a relatively short time interval is all the more difficult. Although these concerns are important, they need not prevent what we envision as a fruitful line of inquiry. In fact, the existing literature suggests that the task of empirically investigating the relationship between EE and EQ improvement may not be as daunting as it would appear at first glance.

Methods

In early 2007, we conducted a preliminary search of air quality education programs in the United States in order to determine whether these programs would likely be able to provide the type and amount of data necessary for this study. "Environmental quality" was narrowed for this study to "air quality" for several reasons. First, comparing programs addressing a variety of environmental quality issues (e.g. air quality, water quality, invasive species, habitat restoration) would likely introduce an overwhelming number of variables for which it would be difficult to control. Second, air quality was chosen as this study's focus because of its links to asthma and children's health (which we believed would have provided an incentive for EE programs to address AQ) and because of the increasing number of programs with a focus on improving *indoor* air quality. We hypothesized that the indoor environment would represent a manageable scale for education programs to engage in environmental quality investigation and real-world problem solving. This initial search produced enough evidence of a large number of high-quality air quality education programs and suggested that a more thorough search was warranted.

Also in early 2007, we convened a symposium of nearly two dozen air quality, place-based learning, and environmental education experts (including nearly all of the project's Steering Committee) from around the country to provide feedback on six research design challenges: refining the research variables; framing research questions; integrating qualitative approaches; criteria for including and excluding programs; anticipated use of findings; and model testing. We also drew on the expertise of the symposium participants to agree upon the following working definition of place-based learning for use in our study:

> *Place-based Learning (PBL), also known as Place-based Education, is a holistic approach to education, conservation and community development that uses the local community as an integrating context for learning at all ages. It fosters vibrant partnerships between schools and communities both to boost student achievement and to improve community health and vitality—environmental, social and economic. PBL has emerged over the past decade through building on the best*

practices of environmental education, retaining a project-focused approach, and opening programs to be tailored by local people to local realities and opportunities.

We used this definition to articulate six core qualities and 12 promising practices of PBL. These qualities and practices were reviewed by a panel of PBL experts and approved by the project Steering Committee.

From May-October 2007, we conducted an exhaustive search of both peer-reviewed and popular literature to identify air quality education programs in the United States. The literature search was conducted using search engines including (but not limited to) Education Research Complete, Environment Complete, Google Scholar, and Academic Search Complete. Table-of-contents email alerts were also received to identify potential programs published in journals including *American Bi-*

Place-based Learning Core Qualities and Promising Practices

Place-based learning addresses three integrated goals: student achievement, including academic achievement, stewardship behavior, civic responsibility, and self-efficacy; community vitality, including economic, political, and social arenas; and ecological integrity. A panel of PBL experts who were also members of this study's Steering Committee drew on their own professional experience and scholarship, as well as relevant published and unpublished literature (see, for example, Chin, 2001; Smith, 2002; Stokely, 2002; and Sobel, 2004), to identify the following six core qualities essential to PBL practice:

- The educational program is grounded in the particular attributes of a place, using local natural and community systems and themes as the context for learning.
- Learning is experiential and/or hands-on, and much of it takes place out of the classroom, on-site in the schoolyard, and in the local community and environment.
- Learning experiences contribute to community vitality and environmental quality by addressing authentic school and community needs.
- Learning is grounded in and supports the development of a love for local community or place.
- Local learning serves as the foundation for understanding and participating appropriately in regional and global issues.
- Learning experiences are supported by the maintenance of existing or the creation of strong local partnerships, including nonprofits, businesses, and government agencies.

The following 12 "promising practices" were identified as contributing to the success of place-based learning programs. However, not every program includes all of these practices.

- Learning is project-based and investigation-focused, providing students with opportunities to apply critical-thinking skills as they conduct comprehensive investigations and work toward resolution of real community priorities.
- The educational program is supported by the local community.
- School or organization leaders recognize PBL as being integral to achieving other institutional goals.
- Learning experiences are tailored to individual learning styles.
- Learning experiences include a focus on issues that are personally relevant to the learners.
- The educational program is initiated by students.
- The educational program is driven or led, but not necessarily initiated, by students.
- The content of the educational program is interdisciplinary.
- The educational program fosters collaboration between the educator/facilitator and the local community.
- The educational program includes a service-learning component.
- Learners have opportunities to work both cooperatively and independently.
- The program includes structure time for students to reflect on their learning.

ology Teacher, *Green Teacher*, *Science and Children*, and *Science Teacher*. One of the outcomes of this work was a comprehensive list of nearly all current and former (within the last ten years) air quality education programs in the United States. AQ education programs were also identified in other countries, including Canada, Australia, and Great Britain, but our study focused primarily on U.S. programs.

We also carried out a nomination process to identify additional air quality programs whose work might have taken place on a smaller scale (e.g. individual classrooms) and would thus be less likely to be featured in the literature. Email listservs, education newsletters, website postings, and phone calling were used to identify as many programs as possible. This resulted in a list of 339 individuals and organizations whose work related to air quality education, though it is likely that thousands of additional teachers throughout the United States incorporate air quality science and issues into their lessons to some degree. Of the 339 identified organizations and individuals, 198 (58%) were categorized as possible participants in our study because they were directly involved with either the delivery of AQ education programs or the design and distribution of AQ-related curricula. These programs were offered on a wide range of scales, from individual classroom efforts to nationally distributed curricula. We were able to obtain contact information for 190 of these programs. (The 141 programs not categorized as possible participants were often involved with AQ education programs in supporting roles, but were not directly involved with implementing AQ education.)

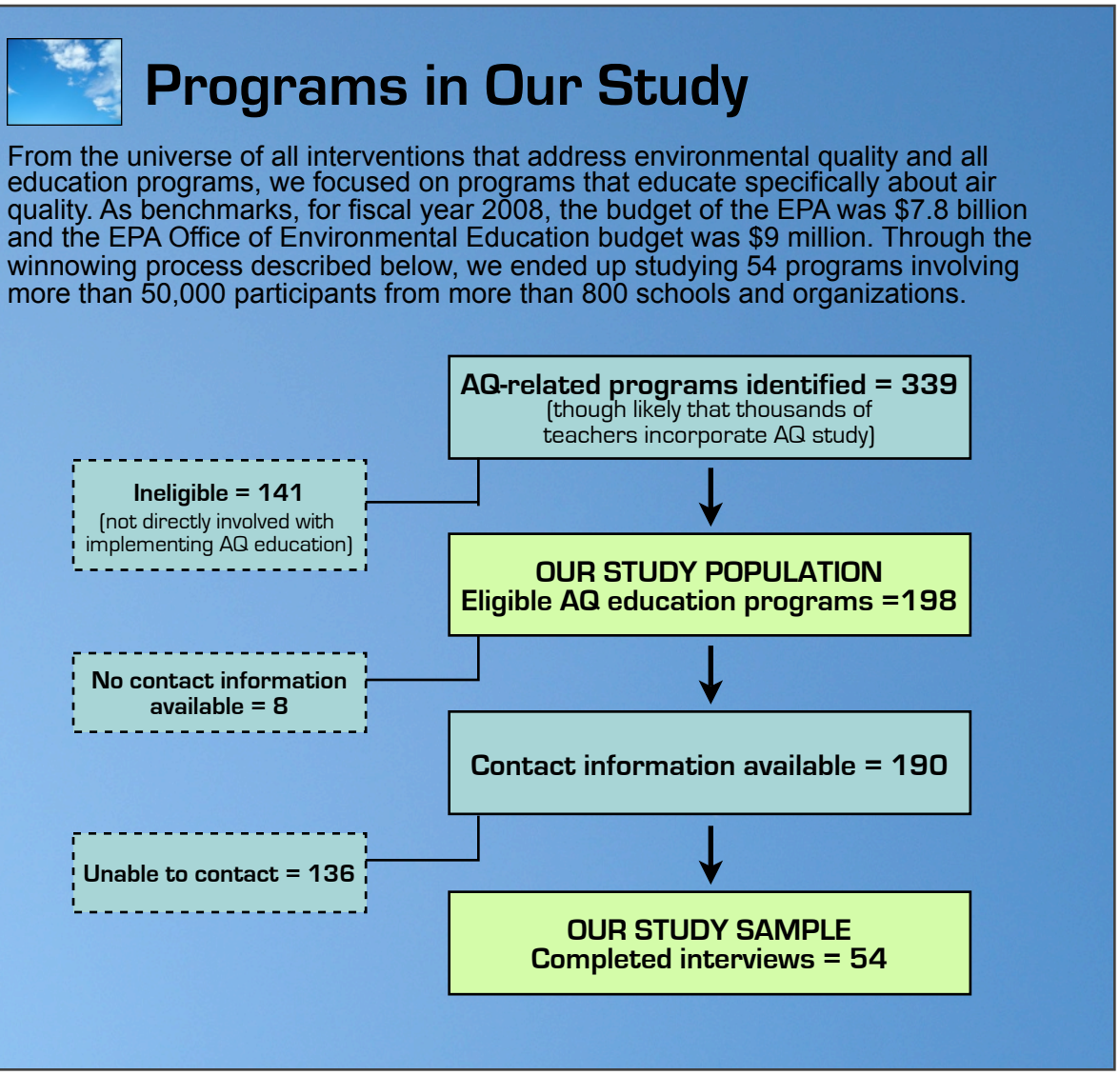
The initial design of our project was based on the hope that enough air quality education programs could be found with existing outcomes data to facilitate the quantitative analysis phase of this project. However, when we examined data from a number of identified programs, we found the data to be highly variable in both content and quality. No two programs had the same types of data, and many data sets were insufficiently complete to permit aggregation for this study. As a result of this preliminary review and because we had found an alterative model in a study of asthma interventions (Center for Managing Chronic Disease, 2007), we decided to collect new data using a telephone survey of program representatives.

In late 2007, we developed a survey instrument (Appendix D) to collect data from the 190 programs and educators for which we had contact information. The 45-minute survey was designed to systematically investigate background information on each program; the extent to which the program embodied the principles of place-based learning; specific air quality education activities included in the program; and program outcome and evaluation data.

One of the potential critiques of this aspect of the study is its reliance on self-report data from teachers or program staff regarding air quality and other environmental impacts. Very few of the identified programs, for example, have published any findings in the peer-reviewed literature. Studies have shown, however, that environmental quality data collected by properly trained volunteers or community members can be as reliable as data collected by professionals (Engel & Voshell, Jr., 2002; Fore, Paulsen, & O'Laughlin, 2001). Some authors (Parris, 1999) have actually urged the scientific community to utilize the potentially sizeable data sets that these "citizen scientists" have been able to collect. We also included questions in the survey instrument about the methods of air quality data collection and analysis used by

each program in order to assess method sophistication.

We attempted to contact via email and/or phone each of the 190 programs we had identified, and left multiple messages when we could not make contact. In the end, we completed interviews with 54 classroom teachers or representatives of air quality education programs—27% of the programs for which we had contact information. The remaining 136 organizations and individuals either 1) were no longer involved with the program that resulted in their nomination (n=14); 2) declined our invitation to participate (n=4); 3) were unresponsive to multiple attempts to communicate with them (n=99); or 4) were unable to complete an interview within the timeframe of our study (n=19). Results of each interview were input into a centralized online database using Survey Monkey and then analyzed using SPSS 14.0 statistical software. Bivariate relationships between programmatic factors and air quality assessment/air quality improvement were analyzed with $\chi 2$ statistics using Fisher's exact tests ($p<.05$) or Pearson product moment correlations for noncategorical variables.



Results

Data from structured interviews with 54 air quality education programs were systematically analyzed in terms of their demographics, types and levels of outcomes, and correlation with place-based learning practices.

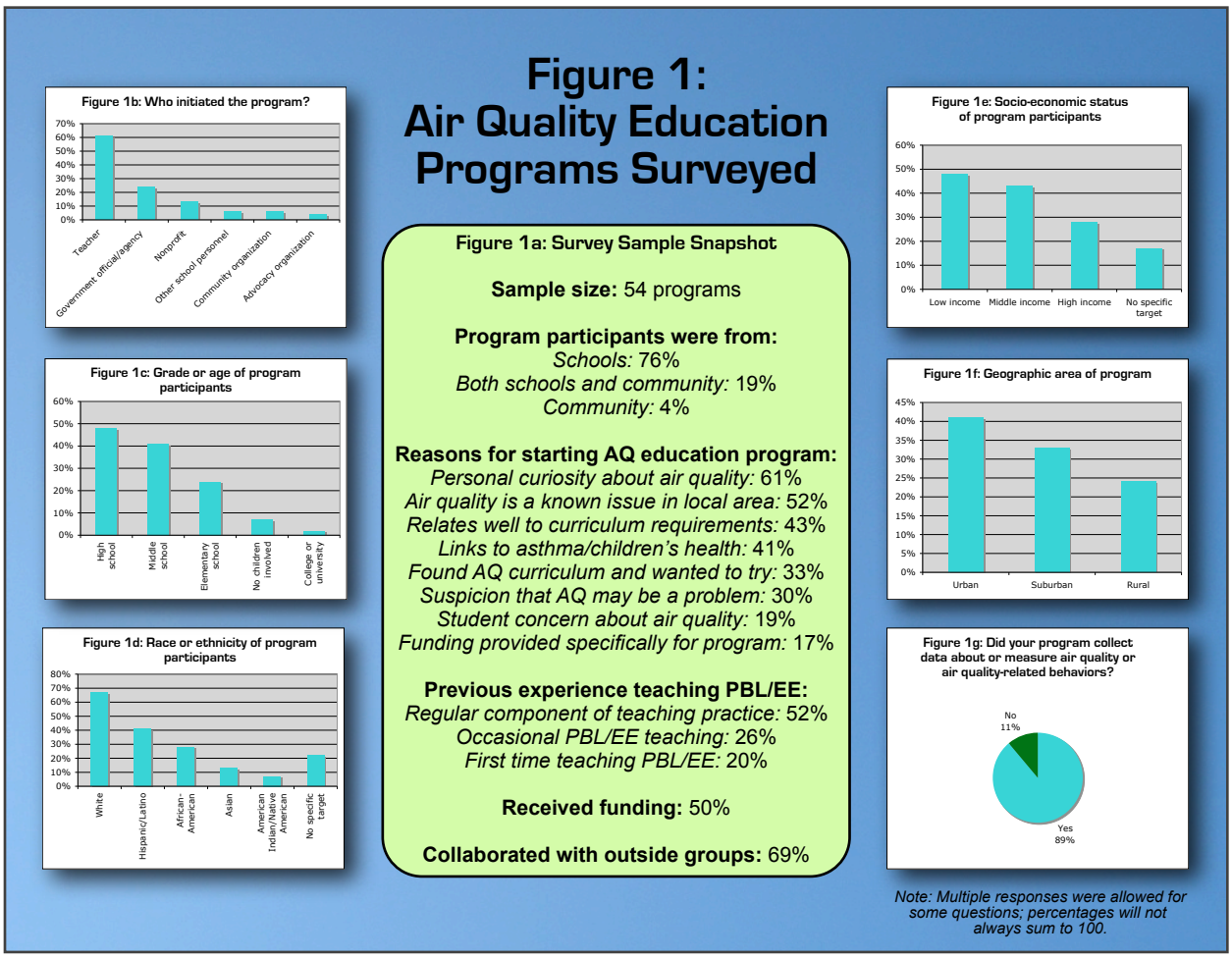
Demographics

Figure 1 briefly describes the 54 programs that we surveyed. A complete summary of descriptive data is included later in this report as Appendix C. Figure 1a shows that our sample was heavily involved in school-based education programs, with 76% of the programs focusing exclusively on school-based audiences. Figure 1a also shows that most respondents named more than one reason for starting an air quality education program. Not surprisingly, reasons such as a personal interest in air quality issues or science (61% of respondents) and links to existing curriculum requirements (43% of respondents) were among the top responses. However, 52% of respondents said that they started their programs because poor air quality was a known issue in their local area. A further 30% suspected that poor air quality was a problem locally. These findings suggest that on-the-ground environmental conditions are significant drivers of education programs about the environment.

Our findings suggest that EE programs are often initiated in response to local environmental conditions.

Figure 1a also illustrates that the majority of respondents were experienced environmental or place-based educators, with 52% reporting that EE or PBL was a regular component of their teaching practice. Additionally, half of the programs received funding to support implementation, and roughly two-thirds of the sample collaborated with other organizations to deliver education programs.

As noted earlier, Figure 1b shows that a majority (61%) of the air quality education programs surveyed were initiated by a teacher. Other initiating individuals or organizations included government agencies (24%), nonprofit organizations (13%), other school personnel (6%), community organizations (6%), and advocacy organizations (4%).



As shown in Figure 1c, the programs in our sample tended to focus on older (middle and high school) rather than younger students, perhaps because the complexity of air quality issues and science may lend itself better to older grade levels. As shown in Figures 1d to 1f, the sample worked with an ethnically and racially diverse range of participants from all socio-economic backgrounds in cities, suburbs, and rural areas. However, the sample was slightly weighted toward lower-income, white, urban students. Finally, Figure 1g indicates that the vast majority of the programs in our sample (89%) collected data about or measured AQ or related behaviors.

More complete information about the programs is provided in tables in Appendices B and C. Among other details, these tables show that the 54 programs in our sample collectively worked with more than 50,000 participants from more than 800 schools.

Types of evidence for air quality improvement

After extensive analysis and comparison of the programs in our sample, we grouped them into three categories based on the type and/or extent of their AQ improvement outcomes: those that provided information only; those that took some kind of action; and those that measured changes before and after an action. (One program did take pre- and post-measurements of physical AQ indicators, but found no improvements in air quality; this program was put into the "Action Taken"

category for our analysis.) Figure 2 provides an overview of the categories, as well as an example of each from our sample.

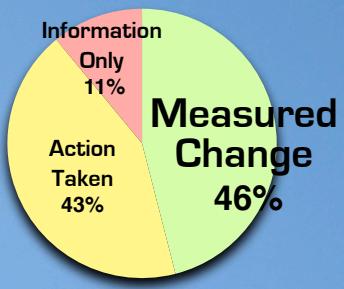
The first outcome category as shown in Figure 2 is "Information Only" (n=6). This category included programs that demonstrated no evidence of efforts to measure AQ or to take other actions to promote AQ improvement. The small number of programs in this category indicates that the vast majority of programs surveyed were involved in measuring AQ, promoting actions to improve AQ, and sometimes even improving AQ.

The programs in the second outcome category, "Action Taken" (n=23), took action to improve AQ but did not display evidence of AQ improvement. The large number of programs in this category (43% of the sample) suggests that AQ education programs, even if unable to demonstrate AQ improvements, tend to be oriented toward promoting AQ improvement actions. The most common actions taken by programs in this category were measuring air quality or related behaviors, reporting findings to a governing body, and advocating for the implementation of an AQ improvement policy.

We chose to include AQ measurement as an improvement action for two reasons. First, AQ measurement is a type of assessment of local environmental quality. Assessment implies evaluation for the purposes of creating change or improvement based on findings. The *intended* result of measurement in our sample of programs was most often an improvement action, whether individual or col-

Figure 2: 46% of programs studied achieved improvements in physical or proxy AQ indicators.

There were three types of programs in our sample: Those that provided information only, those that took some kind of action, and those that measured changes before and after an action.



Information Only

Program provided education and/or information about AQ, but displays no evidence of AQ improvement outcomes; AQ was not assessed as part of program activities; no actions known to be taken as part of program.

n of programs in sample = 6

Example:
North Carolina DNR
Outreach presentations at schools and churches about the effects of poor air quality and things individuals can do to help improve AQ.

Action Taken

Program displays no evidence of AQ improvement outcomes, but assessed AQ/related behaviors or took action to promote AQ improvement.

n of programs in sample = 23

Example:
Rose Foundation (CA)
High school students monitored AQ near their school and contacted local officials, wrote to polluting industries, and took part in press conferences.

Measured Change

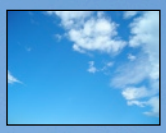
Program displays evidence of physical or proxy AQ indicator improvement outcomes.

n of programs in sample = 25

n with physical AQ improvement = 6
n with proxy AQ improvement = 19

Example (proxy AQ improvement):
Exeter (NH) High School
Students studied AQ issues and monitored car pooling and idling behaviors in school drop-off area. Program resulted in a no-idling policy and installation of no-idling signs.

Example (physical AQ improvement):
East Valley (WA) Middle School
Students monitored school IAQ and worked with school administrators to implement structural changes resulting in improved carbon dioxide, air flow, particulate levels, odors, and mold.



What Do We Mean by Physical and Proxy Indicators?

Indicators are commonly used to evaluate progress toward programmatic targets and goals. The literature on program evaluation and indicator development recommends that "indicators should be clear, relevant, economic, adequate, and monitorable…. The more precise and coherent the indicators, the better focused the management strategies will be" (Kusek & Rist, 2004, p. 68). In evaluating environmental quality, two types of indicators are predominantly used: physical indicators and proxy indicators.

A physical indicator is a "numerical value derived from actual measures of a stressor, state, or ambient condition, exposure, or human health or ecological condition" (U.S. Environmental Protection Agency, 2008, p. 1-3). In assessing air quality, the EPA uses physical indicators such as ambient concentrations of carbon monoxide and particulate matter, and the number of homes above the EPA's radon action level.

A proxy indicator is used when physical indicator data is "not available, when data collection will be too costly, or if it is not feasible to collect data at regular intervals" (Kusek & Rist, 2004, p. 70). However, because proxy indicators are indirect or approximate measures of an outcome or target, they must be as clear and precise as possible.

The U.S. Environmental Protection Agency relies primarily on physical indicators to assess environmental quality and environmental protection goals. However, the agency recognizes the value of proxy indicators such as the number of permits issued or the number of enforcement actions taken. The EPA reports that evaluating EQ based on a combination of physical and proxy indicators may be particularly useful for evaluating programs or projects that focus on a particular place or issue (U.S. Environmental Protection Agency, 2008).

In our study, the most common proxy indicators for which programs in our sample had data were car and bus idling rates, and the implementation or strengthening of an air quality policy.

lective. Second, air quality measurement goes beyond the passive receiving of "information only" that is the diagnostic criterion of programs in the first category by actively engaging participants in the learning process and by facilitating hands-on interaction with an environmental issue.

Finally, the third outcome category, "Measured Change" (n=25), included nearly half (46%) of the programs surveyed. These programs measured changes in either physical (e.g. carbon dioxide, particulates) or proxy (e.g. implementation or strengthening of AQ policies such as car or bus idling restrictions) AQ indicators. Of these, one program demonstrated improvements in physical AQ indicators only, five programs demonstrated improvements in both proxy and physical AQ indicators, and 19 programs demonstrated improvements in proxy AQ indicators only. The low number of programs that measured changes in physical AQ indicators suggests how difficult it is to document improvements in physical AQ, and also the importance of the concept of proxy indicators.

Overall, combining the programs in the second and third outcome categories ("Action Taken" and "Measured Change"), a total of 89% of the programs in our sample took action to improve AQ, some of which resulted in measurable improvements in physical or proxy air quality indicators.

PBL qualities and practices

Table 1 describes the specific PBL qualities and practices reported by the programs in our study sample. Each of the programs surveyed was asked to rate the degree to which

Table 1: PBL qualities and practices in programs studied

All programs surveyed embody many PBL qualities and practices. Two-thirds of programs surveyed rated strong on four of six PBL core qualities.

	% of programs reporting quality as 'strong'
Program was personally relevant to learners.	89%
Program was experiential or hands-on.	85%
Promoted understanding on larger scale.	85%
Used the local environment as context for learning.	80%
Students worked individually and in groups.	76%
Program was project-based.	74%
Supported by school/organization leadership.	74%
Contributed to authentic community needs.	72%
Content was interdisciplinary.	67%
Tailored to individual learning styles.	56%
Promoted attachment to local place and/or community.	54%
Included a service-learning component.	46%
Included structured reflection by students.	39%
Utilized existing or created new local partnerships.	35%
Fostered collaboration with local community.	33%
Program was driven by students.	32%
Supported by local community.	30%
Program was initiated by students.	11%
n of programs with rating of 'strong' on 4 or more of the 6 core qualities	34/54 (63%)
n of programs with rating of 'strong' on 3 or fewer of the 6 core qualities	20/54 (37%)
n of programs with rating of ''somewhat' or 'strong' on 4 or more of the 6 core qualities	54/54 (100%)

Denotes PBL core quality

their program included each of 18 PBL practices. For each of these qualities, respondents were asked to choose from three possible descriptors: not at all, somewhat, or strong. As shown Table 1, many of the qualities and practices of PBL were relatively common in the programs surveyed.

For example, 89% of the programs reported that their programs were personally relevant to learners, and only one of the 18 qualities was endorsed by less than 30% of the programs. Nine of the 18 PBL qualities and practices were reported as "strong" by more than two-thirds of our sample.

Aggregating these qualities provides additional evidence of the degree to which the programs studied embodied the principles of PBL. For example, 100% of the programs self-rated as "somewhat" or "strong" on at least four of the six PBL core qualities, and

63% of the programs self-rated as "strong" on at least four of the six PBL core qualities.

While the strength of PBL qualities and practices in our sample may have been influenced by the somewhat limited utility of our three-point rating scale (as will be discussed later), the finding may also be due to the fact that many of the individual PBL qualities and practices are also recognized as good education practices. While the degree to which the programs in our sample employed and integrated the PBL practices varied, PBL's uniqueness lies in its integration of all of the qualities. Table 1 also shows that 80% of the programs surveyed reported as "strong" what is perhaps the cornerstone of PBL: "The program used the local environment as a context for learning."

Table 1 also suggests that some of the qualities and practices that are perhaps more time-intensive or perceived as more difficult to implement were reported as "strong" by the fewest respondents. For example, the practice "fostered collaboration with the local community" was reported as strong by just 33% of the programs surveyed. This may be influenced by the fact that building relationships outside of classrooms or other education environments typically requires significant investments of time and commitment on the part of an educator or program coordinator. Similarly, the practices "program was driven by students" and "program was initiated by students" were reported as "strong" by 32% and 11% of our sample, respectively. This may be due to the fact that turning over control of the educational process to students or participants is often perceived as more time-consuming.

76% of the programs that reported physical or proxy AQ indicator improvements were classified as "Higher PBL."

Levels of PBL practice

Survey respondents rated each of the 18 PBL characteristics 1, 2, or 3 (not at all, somewhat, or strong), and a total score was created by summing the scores of all items. The possible range for total scores was thus 18-54. Since most participants endorsed many PBL characteristics as either "somewhat" or "strong" the total PBL score in our sample ranged from 34 to 53. These scores were divided into two groups as close as possible to the midpoint in our sample. An exact 50-50 split was not possible because five programs had a PBL score of 43 and four programs had a PBL score of 44. PBL scores for those in the "Lower PBL" group (n=25) ranged from 34-43, a range of nine. PBL scores for those in the "Higher PBL" group (n=29) ranged from 44-53, a range of 11. Table 2 shows the relationship between higher and lower PBL scores and the number of programs that took action to improve AQ, and improved physical and/or proxy AQ indicators.

The results show that programs demonstrating improvements in either physical or proxy AQ indicators were more often classified as "Higher PBL." Of the six programs that reported improvements in physical AQ indicators (Table 2a), for example, 83% were classified as "Higher PBL." Only one of the programs that reported physical AQ improvements was classified as "Lower PBL." This finding did not achieve statistical significance, however, likely due at least in part to small sample size.

Of the 25 programs that reported improvements in either physical or proxy AQ indicators (Table 2b), a statistically signifi-

Table 2: Programs with more PBL qualities and practices report more improvements in AQ.

Table 2a: Programs with improvements in physical AQ indicators (n=6)

	n of programs	Lower PBL	Higher PBL
Carbon dioxide	3	0	3
Air flow	2	0	2
Particulates	2	0	2
Temperature	1	1	0
Relative humidity	1	0	1
Odors	3	1	2
Presence of animals	0	0	0
Damp or mold	1	0	1
Any physical AQ indicators improved	**6**	**1 (17%)**	**5 (83%)**

Table 2b: Programs with improvements in physical or proxy AQ indicators (n=25)

	n of programs	Lower PBL	Higher PBL
AQ policy implemented or strengthened	14	3	11
AQ control or remedial measures implemented	11	1	10
Car or bus idling	3	2	1
Bus ridership	3	2	1
Car pooling	3	1	2
Walking/bicycle riding	3	1	2
Any proxy AQ indicators improved	**24**	**5 (21%)**	**19 (79%)****
Any physical or proxy AQ indicators improved	**25**	**6 (24%)**	**19 (76%)****

Table 2c: Programs that took action to improve AQ (n=48)

	n of programs	Lower PBL	Higher PBL
Assessed AQ or related behaviors	42	17	25
Reported results to governing body	28	7	21
Advocated for AQ policy implementation	23	5	18
Other	18	4	14
Any action taken to improve AQ	**48**	**21 (44%)**	**27 (56%)**
Any physical or proxy AQ indicators improved, or any action taken to improve AQ	**48**	**21 (44%)**	**27 (56%)**

n *of programs with no improvement in any areas or did not take action = 6*

** significant at .01 level (2-tailed)

cant 76% ($p<.01$)[2] were classified as "Higher PBL" (24% were "Lower PBL"). However, when programs that took action to improve AQ were included, the difference was much less pronounced. Of the 48 programs that reported improvements in AQ indicators (physical or proxy) or took action to improve AQ, 56% were classified as "Higher PBL" and 44% were classified as "Lower PBL." This finding suggests that the extent to which a program implements PBL practices may be a predictor of AQ improvement outcomes, but not as strong a predictor of whether a program simply takes action to improve AQ. This in turn may reflect a selection bias in our sample since the vast majority of programs in our sample (89%), whether highly place-based or not in their approach, took some sort of action to improve AQ.

Table 2 also includes a substantial amount of descriptive data about our sample, especially in relation to AQ improvement outcomes. Each program was asked which types of AQ indicators (if any) were measured as part of the program, and whether the program included post-tests to determine indicator improvement. The indicators included in our survey were drawn from the EPA's common indicators for air quality (U.S. Environmental Protection Agency, 2008). For indoor air quality indicators, we drew heavily from the EPA's *Tools for Schools* program recommendations (U.S. Environmental Protection Agency Indoor Environments Division, 2005). Programs were also asked to name any other AQ indicators that were measured and, when applicable, improved. These responses were included in our final analysis.

Table 2a shows that of the programs that reported improvements in physical AQ indicators, the most common improvements were in carbon dioxide levels (n=3) or the presence of odors (n=3). Programs also reported improvements in air flow (n=2), particulates (n=2), temperature (n=1), relative humidity (n=1), and damp or mold (n=1).

We also asked programs about measurements they may have taken that were related to AQ (proxy indicators). Twenty-four programs in our sample reported improvements in proxy AQ indicators (Table 2b). For example, 14 programs reported the implementation or strengthening of an AQ policy as a program outcome. Of these, 11 (or 79%) were classified as "Higher PBL." Similarly, 11 programs reported the implementation of an AQ control or remedial measure (e.g. the installation of a new ventilation system). Of these, 10 (or 90%) were classified as "Higher PBL."

Finally, Table 2c highlights the actions that the programs in our sample took to improve AQ. Forty-two programs reported measuring AQ or related behaviors. Of these, 28 reported their results to a governing body in an effort to promote AQ awareness and/or improvements. Further, 23 programs advocated for the implementation of an AQ policy. As noted earlier, these findings suggest that even if they were unable to demonstrate measurable improvements in physical or proxy AQ indicators, the vast majority of programs in our sample took some type of action to improve AQ.

Specific PBL practices

Table 3 documents the correlations between specific PBL practices and types of AQ improvement reported by our sample. The strongest correlations emerged between specific PBL practices and improvements in either proxy or physical AQ indicators. This

[2] For this and all subsequent Chi square analyses, p values are for 2-tailed tests.

Table 3: Correlations between specific PBL practices and types of air quality improvement

	Improvement in physical AQ indicators (n= 6)	Improvement in proxy AQ indicators only (n=19)	Improvement in proxy or physical AQ indicators (n=25)	Improvement in proxy or physical AQ indicators, or action taken (n=48)
Included a service-learning component.	.21	.26^{t}	.38**	.21
Contributed to authentic community needs.	.09	.28*	.33*	.04
Supported by school/organization leadership.	.08	.26^{t}	.30*	.28*
Utilized local partnerships.	.18	.20	.30*	.05
Supported by local community.	.19	.18	.29*	.10
Program was experiential or hands-on.	.15	.20	.28*	.18
Program was driven by students.	.13	.15	.23	.26^{t}
Program was project-based.	.19	.10	.22	.45*
Fostered collaboration with local community.	-.09	.27*	.21	.17
Students worked individually and in groups.	.19	.06	.18	.01
Promoted understanding on larger scale.	-.02	.20	.18	.02
Content was interdisciplinary.	.13	.11	.18	.13
Program was initiated by students.	.19	.01	.12	.15
Promoted attachment to place/community.	-.10	.17	.10	.00
Included structured reflection by students.	-.02	.11	.10	.18
Program was personally relevant to learners.	-.25^{t}	.26^{t}	.09	.06
Used the local environment as learning context.	.06	-.08	-.04	.26
Tailored to individual learning styles.	.10	-.23	-.16	-.20

** $p<.01$ (2-tailed) | * $p<.05$ (2-tailed) | ^{t} $p<.10$ (2-tailed) | Denotes PBL core quality

analysis suggests that the strongest predictor of proxy or physical AQ indicator improvement is the inclusion of a service-learning component[3] ($r=.38$, $p<.01$). Other significant ($p<.05$) predictors of proxy or physical AQ indicator improvement were whether the program contributed to authentic community needs ($r=.33$); was supported by school/organization leadership ($r=.30$); utilized local partnerships ($r=.30$); was supported by the local community ($r=.29$); or was experiential or hands-on ($r=.28$).

A few statistically significant positive correlations also emerged between specific PBL practices and improvements in proxy AQ indicators. For example, we found moderately strong correlations ($p<.05$) between proxy AQ indicator improvements and the PBL

[3] For the purposes of our survey, service-learning was defined as an education method in which students contribute a positive service to the school or community, and which also actively supports the goals of their academic learning.

practices "contributed to authentic community needs" (r=.28) and "fostered collaboration with the local community" (r=.27). Trends (p<.10) were observed for correlations between proxy AQ indicator improvements and the PBL practices "included a service-learning component" (r=.26) and "supported by school/organization leadership" (r=.26).

No statistically significant correlations were found between any individual PBL practices and improvements in physical AQ indicators. This may have been due to the relatively low number of programs in our sample that reported physical AQ indicator improvement outcomes (n=6).

When we analyzed the relationship between specific PBL practices and physical/proxy AQ indicators *or* action taken by a program to promote AQ improvement, the strongest predictor was the degree to which the program was project-based (r=.45, p<.05). The strength of this correlation may derive from the fact that programs with a strong project-based orientation are more likely to require final outcomes at the end of the project. This suggestion is further supported by an observed correlation trend between improvements in physical or proxy AQ indicators, or action taken by a program to promote AQ improvement, and the PBL practice "program was driven by students" (r=.26, p<.10). The only other PBL practice to achieve a statistically significant correlation in this category was school/organization leadership support (r=.28, p<.05).

Aggregate PBL practice

When controlling for all other variables, the strongest predictor of proxy or physical AQ indicator improvement was the degree to which a program incorporated the qualities and principles of place-based learning. Table 4 shows a strong correlation between PBL score and improvements in proxy or physical AQ indicators (r=.40, p<.01). While correlations between PBL score and other AQ improvement categories were also statistically significant, our findings suggest that the *combination* of proxy and physical indicators represents the most potent EQ predictive criteria.

Table 4: Correlations between extent of PBL qualities/practices and types of AQ improvement

	Total score for all PBL qualities and practices	Total score for core PBL qualities only
Core PBL score (total of 6 core categories)	.75***	1
Any physical AQ indicators improved	.20	.13
Any proxy AQ indicators improved	.29*	.31*
Any physical *or* proxy AQ indicators improved	.40**	.38**
Any action taken to improve AQ	.30*	.18
Any physical *or* proxy AQ indicators improved, or any action taken	.30*	.18

*** p<.001 level (2-tailed) ** p<.01 level (2-tailed) * p<.05 level (2-tailed)

Note: n=*54 for all Pearson correlation calculations.*

Discussion

The data we collected resulted in a rich portrait of the common features, strengths, and challenges of the 54 air quality education programs in our sample. Three key findings emerged from our analysis.

Key Finding #1: Nearly half (46%) of the programs studied reported evidence of improvements in air quality.

Of the 54 programs in our sample, 46% reported improvements in physical or proxy air quality indicators. When we started this research, we hypothesized that at least some education programs could be found with evidence of improved air quality, but we had no idea that environmental improvements would be so common. The finding that nearly half of the programs in our sample reported improvements in physical or proxy AQ indicators provides evidence of the important role education programs can play in achieving environmental protection goals.

Our findings provide evidence of the important role education can play in achieving environmental protection goals.

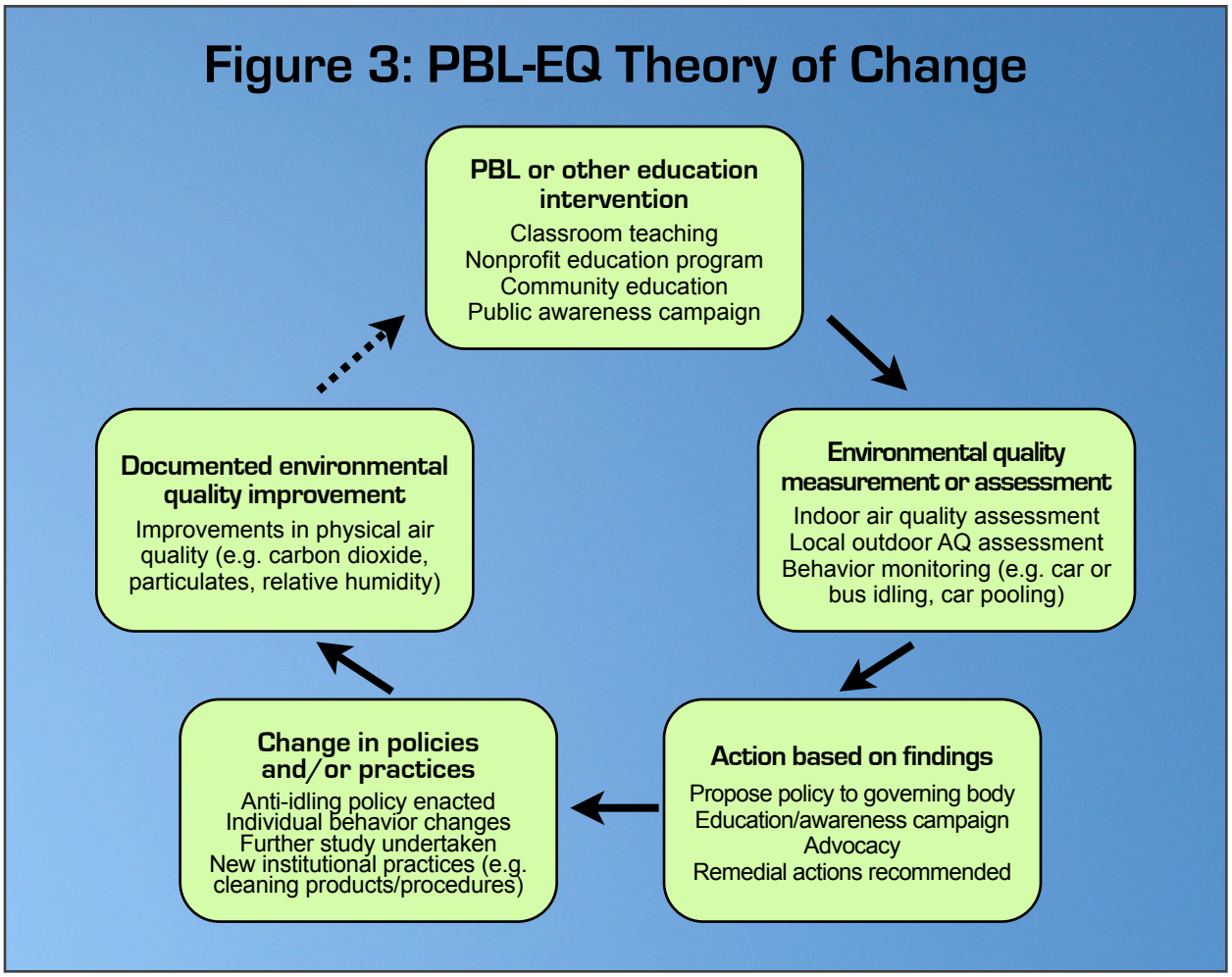
Further, our data suggest that proxy indicators may be a critical ingredient in measuring the PBL-EQ relationship. For example, the correlation between physical AQ indicators alone and PBL did not achieve statistical significance. When proxy indicators were included, however, the correlation between PBL and AQ improvement outcomes was quite strong (r=.40, p<.01). The correlation between PBL and proxy AQ indicator improvement only was also strong (r=.29, p<.05), but did not provide as much traction as the combination of physical and proxy indicators.

When we began our study, we did not anticipate including proxy indicators in our analysis. In fact, formal discussion of proxy indicators in relation to PBL or EE program impacts has not been taking place in the research literature to any significant extent. However, proxy indicators are being widely used to understand and monitor the impacts of other types of environmental interventions. Most often such measures have been used when more specific indicator information is of poor quality or unavailable, or is limited due to time constraints

or cost (Kusek & Rist, 2004). PBL and EE programs face similar constraints in documenting EQ impacts. For example, education programs are often short-term projects with limited budgets. EQ, on the other hand, is a complex, systemic phenomenon, and it can often take years, decades, or even longer before changes in EQ are unequivocally measured and recorded. While the short duration and financial constraints of most PBL or EE programs may limit their ability to demonstrate outcomes related to physical EQ indicators, the number of programs in our sample with demonstrated improvements in proxy indicators suggests that proxy indicators could be effectively used to investigate the PBL-EQ relationship.

Key Finding #2: Most (89%) of the programs studied took some form of action to promote air quality improvement.

One of the strongest themes in our data is that the vast majority of air quality education programs are not just teaching about air quality; they are taking action to improve it. Of the 54 programs in our sample, 89% took action to improve air quality. To describe this finding, we constructed a five-stage "PBL-EQ Theory of Change" (Figure 3). The model was based on our initial exhaustive search for air quality education programs in the U.S., and reinforced by the data collected from the 54 air quality education programs we interviewed. Although the model implies a developmental progression that could be recom-



mended for *individual* programs, for now we are only proposing it as a heuristic device to better understand and categorize the range of approaches used by existing programs.

As shown in Figure 3, programs that demonstrate improvements in physical AQ indicators typically complete each of the five elements in the change model. Programs that demonstrate improvements in proxy AQ indicators typically complete the first four elements, while programs that take action tend to complete the model's first three elements. Roughly speaking, the more elements of the model a program includes, the more likely the program is to achieve environmental quality improvement outcomes. For example, a number of the programs in our sample first diagnosed existing problems in order to obtain baseline data. They measured both physical air quality (e.g. carbon dioxide, particulates), and also AQ-related behaviors (e.g. bus idling rates, car pooling rates). These data then enabled program participants to take some sort of action to promote AQ improvement. Based on these actions, changes were sometimes made to existing AQ-related policies or procedures (proxy indicators). These changes frequently required the support of school, organization, or community leaders in order to be implemented, once again highlighting the importance of the PBL qualities that focus on community engagement. Finally, post-measurement of AQ indicators was necessary in order to document improvement outcomes.

The more elements of the change model that a program included, the more likely it was to report EQ improvement outcomes.

While our change model needs further investigation and testing, it has strong potential for guiding PBL and EE program designers and educators. Future testing and refinement of the change model will help us better understand and strengthen the connections between the five elements. It will also help us better understand how and why PBL and EE programs result in EQ impacts. This understanding will be important to future studies that investigate more complex environmental quality issues such as climate change.

*Key Finding #3: Programs reporting more place-based learning practices also showed more evidence of improved air quality (*r=*.40,* p<*.01).*

The degree to which a program incorporated PBL was the strongest predictor of improvements in physical or proxy AQ indicators. Program funding (r=.24, p<.10) and instructional dose (i.e. the number of hours the average participant took part) (r=.19, p<.10) achieved marginally significant associations with AQ improvement, but were not as strong as PBL in predicting AQ improvement outcomes. The impacts of many other potential predictors, including program duration, number of teachers involved, and number of program participants, were also analyzed, but none of these factors achieved statistical significance.

Our findings may actually underestimate the impact of PBL practices. First of all, the overall high level of PBL in our sample restricts the variability of PBL scores. This means that in a sample with a greater range of educational practices, even stronger correlations between PBL characteristics and EQ improvements might be found. Secondly, the relatively small sample size means that any effects that achieve statistical significance must be relatively robust.

However, as much as our study supports a strong relationship between PBL and air quality improvement, our study also suggests the need for further research to explicate which *specific* educational experiences carry the greatest weight. When we analyzed the relationships between individual PBL qualities and AQ improvement outcomes, we found that several of the most important factors are also considered hallmarks of other innovative approaches to education such as service-learning and experiential education, or of generic best practices in education.

PBL "core qualities" by themselves were not the strongest predictors of AQ improvement outcomes.

For example, the inclusion of a service-learning component (r=.38, p<.01) and a contribution to authentic community needs (r=.33, p<.05) were the most significant PBL qualities that predicted AQ improvement outcomes. Support from school or organization leadership (r=.30, p<.05), utilization of local partnerships (r=.30, p<.05), support from the local community (r=.29, p<.05), and an experiential or hands-on approach (r=.28, p<.05) were also factors that achieved statistical significance.

These findings suggest that what we call this type of education (for example, PBL or EE or service-learning) may be less important for achieving EQ impacts than whether it incorporates certain key qualities and practices. As Table 3 highlights, the PBL characteristics that our expert panel had identified as PBL "core qualities" were not necessarily the strongest predictors of AQ improvement outcomes by themselves. Even though the combination of all PBL qualities and characteristics achieved the strongest correlation, the strongest predictors of AQ improvement may center around a cluster of component practices that are not unique to PBL, service-learning, or other educational approaches. Our findings suggest that a PBL approach has enough of these practices to make it an effective strategy for AQ improvement, but other approaches may be effective as well. The search for effective common practices would seem to be an important avenue for future research, as would effort to more clearly articulate and study the practices that uniquely distinguish related educational approaches from each other.

Limitations and Suggestions for Future Research

We have identified four main limitations to our work thus far: potential sample bias; imprecise measures of PBL qualities and practices; a potential tautology between our improvement categories and PBL practices; and the difficulty of assessing improvement in complex, long-term environmental problems. Addressing these limitations guides our suggestions for future avenues of research.

First, it is unclear how representative our sample was of both air quality programs and programs that address EQ in general. With participation of a little more than one-fourth of the candidate programs for which we had contact information, it is possible that our sample was biased in some ways. Additionally, participants in our study were self-selected based on their willingness to respond to our inquiries and website postings seeking AQ educators and programs. This may have resulted in a program sample that was skewed toward those especially committed to teaching about AQ.

To address this first limitation, we recommend replicating our research design using a larger and/or stratified, random sample. We also recommend replicating our research design focusing on a different EQ topic (e.g. climate change) in order to determine whether our findings apply only to AQ or whether there is broader application to EQ improvement in general. The limitations in our sample structure could also be addressed by designing future studies that utilize experimental or quasi-experimental designs of crucial cases (Goggin, 1986).

A second limitation of our work is that our findings may be constrained by the rudimentary measures of specific PBL qualities and practices that we employed. As noted earlier, we used a three-point scale (not at all, somewhat, or strong) for respondents to self-rate their inclusion of each PBL quality or practice in their AQ education programs. Many of the respondents may have been reluctant to respond "not at all" to many of the qualities, since many are closely aligned with dominant models of pedagogy and educational practice (e.g. "tailored to individual learning styles"; "program was project-based"). It is possible that a more nuanced scale may have resulted in a more detailed

picture of PBL qualities and practices in the programs surveyed.

Future studies would benefit from further research and clarification of terminology and definitions. For example, we acknowledge that the PBL characteristic, "includes a service-learning component," represents a complex and rich field in and of itself. Indeed, many of the other PBL qualities are also used in definitions of service-learning and hands-on or experiential approaches to learning, all of which are being increasingly recommended for science education. Including questions that ascertain the use of these approaches as well as PBL would seem to be important in future work. Future studies could also investigate the extent to which programmatic goals (e.g. whether the program is specifically designed to attempt to impact environmental quality) predict EQ improvement outcomes. Service-learning's strong correlation in our study, for example, may be partly explained by a common goal of service-learning programs to create change in communities.

Case study research has the potential to provide richer descriptions of best practices that achieve EQ improvements.

We also see an important role for case study research in addressing the second limitation. Qualitative research, and case study research in particular, has the potential to provide richer descriptions of best practices of programs that achieve environmental quality improvements. It is exactly this rich description of specific practices that is most likely to inform designers of educational programs. Case study research could also help us better understand which of the 18 PBL characteristics analyzed in our study are the most potent in establishing associations with EQ improvement outcomes, in what combinations, and under what conditions. We especially recommend further investigation of the individual PBL characteristics that correlated strongly with AQ improvement outcomes (e.g. service-learning, addressing community needs).

A third limitation of our work is a potential tautology between the typology of the three AQ improvement outcome categories we created and the methods of PBL. It could be argued *a priori* that both attempting to improve the environment and having students attempt to measure such improvements are goals that would be more commonly found in PBL programs than in more traditional educational approaches. Therefore our finding that such outcomes were in fact more common could be viewed as tautological.

We were aware of this potential confound from the outset but decided to use the current design because it did not impact our primary question, which was whether education can play a role in improving environmental quality. Prior to this study there had been no studies that had specifically asked this question in a general sample of programs and we felt it was essential to begin with a prevalence estimate. It was only our secondary question regarding whether a PBL approach was associated with more environmental quality improvement that would have been affected by the potential confounding of program approach and the three categories of AQ improvement outcomes. Further research could investigate the relative impacts of PBL versus other educational approaches.

The fourth limitation is that physical AQ improvement outcomes are difficult to measure because they are multiply determined,

long-term, and large-scale. This will almost certainly be the case for other EQ areas (e.g. water quality, climate change), and it is perhaps one of the largest hurdles to this research in general. We recommend two areas for future research to address this fourth limitation.

First, as noted earlier, further investigation of the role of proxy indicators in understanding EQ outcomes of education programs will be crucial. We envision research that examines the development and application of proxy indicators in other environmental program and research arenas (e.g. sustainable development), and then creates and tests strategies and protocols for designing proxy indicators specific to education programs.

Second, the complex nature of EQ evaluation also suggests an important role for understanding the *scale* of impact of education programs that address environmental quality. For example, some of the programs in our sample achieved improvements in indoor air quality relative to one or two rooms in a single building. Other programs, however, achieved policy improvements applicable to an entire school district or city. Both of these achievements are important. However, our research does not distinguish between scales of impact. We envision a robust line of future inquiry that addresses this issue of scale, perhaps incorporating Short's (2007) EEPI tool.

Implications for Policy and Practice

While further investigation is necessary to understand the relationship between PBL and environmental quality, our present findings may have more immediate utility for policy makers, educators, and program designers. Policy makers, for example, should consider this study's finding that education can be an effective response to environmental problems. Our findings suggest that education should be a valued and supported aspect of government and NGO conservation projects. Policy makers may even want to consider a new category of financial support for projects that actively attempt to improve environmental quality primarily through education programs.

Our findings suggest that education should be a valued and supported aspect of conservation projects.

Policy makers should also bear in mind that education programs may be able to deliver significant benefits at relatively low costs. Half of the programs in our sample, for example, received no financial support. An additional 25% of programs received less than $10,000 over the entire duration of the program. Our findings suggest that education programs are achieving significant impacts on shoestring budgets. Increasing funding for education programs that specifically address environmental quality may provide a good return on investment.

Increased policy support for education that addresses EQ would also likely help to advance the discussion of EQ outcomes and impacts within the environmental education community itself. In previous decades, EE research and practice have focused largely on environmental attitude and behavior change outcomes. It is likely that many EE practitioners do not even consider EQ impacts when designing and implementing programs. While we do not mean to suggest that *all* environmental education programs should result in EQ improvement outcomes, we do believe that the field of EE would be strengthened by increased dialogue on this topic.

Finally, both the content and methodological findings from this study suggest that further investment is warranted for research

that refines our understanding of the connection between education and environmental quality.

In regard to implications for practitioners, educators with an expressed goal of addressing environmental quality issues should consider adding measurement and assessment components to their programs. Consistent with our theory of change (Figure 3), actual AQ measurement or assessing related behaviors appeared to be essential ingredients in subsequently taking action based on findings and improving AQ. Thus, educators and program designers should consider including environmental quality measurement at both the beginning and end of an education program. Fewer than 25% of the programs in our sample took follow-up measurements of physical AQ or AQ-related behaviors. The most common reason for not taking post-program measurements was that it was not part of the program design or goals. This suggests that explicitly including pre- *and* post- EQ measurement activities in education programs could create a rich pool of EQ outcomes data for use by future studies.

Our findings also suggest that educators and program designers should be less concerned about what they call their programs (e.g. environmental education, place-based learning, service-learning), and more focused on the inclusion of specific educational practices that engage participants in their local communities by investigating and measuring real-world environmental quality issues. Programs should also actively consider building collaborative relationships with individuals and organizations that can provide support, expertise, and even resources, since community involvement and support was a statistically significant factor in predicting AQ improvement outcomes.

Conclusion

Can education programs improve the environment? Our findings provide preliminary evidence that education programs can, at least in the case of physical or proxy indicators of air quality, be a viable approach for achieving measurable improvements in environmental quality. This study found that many education programs reported evidence of improvements in physical or proxy air quality indicators, that most education programs in our sample were taking action to improve air quality, and that place-based learning practices were a significant predictor of such improvements.

At the beginning of this project, we hypothesized but were by no means sure that a quantitative approach to research into the PBL-EQ relationship was even possible. While a handful of examples of related research had been found in the literature, we wondered whether challenges related to data availability, data quality, and longitudinal measurement were simply too great to be overcome. Despite the limitations to our research (discussed previously), this two-year project has demonstrated that it *is* possible to quantify a relationship between place-based learning and environmental quality using relatively simple inferential statistical methods.

While our findings should certainly be considered as first steps on a long-term research path, this "proof of concept" opens a door to a rich line of future inquiry for both the environmental protection and education research communities. Our program survey methodology could be a useful tool for understanding how programs that address other EQ areas such as water quality, climate change, and sustainability are taking action to improve the environment. We also see tremendous potential for case study research, model testing, and experimental design in this work. We also believe our findings are robust enough to warrant immediate field-testing by place-based and environmental educators and by environmental protection advocates who are seeking ways to enhance current policy and physical interventions.

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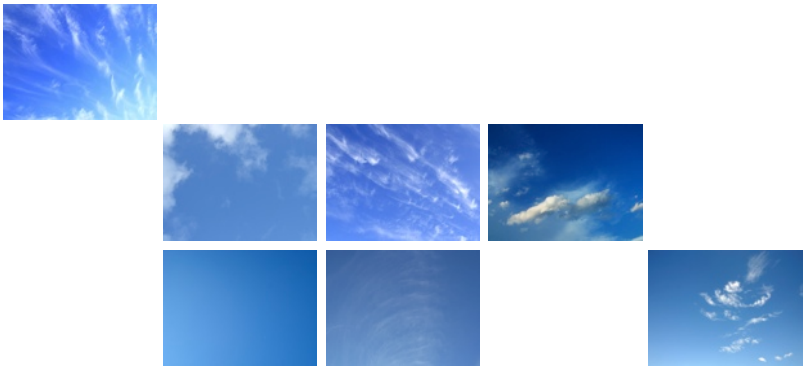

Appendix A: Acknowledgments

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Michael Duffin, Michael Murphy,
and Brian Johnson
Shelburne Farms Project Team
December 2008

Appendix B: Participating Programs

Programs that reported improvements in physical air quality indicators:

AirNET
Hillsborough, NH
Program worked with schools throughout New England. Provided AQ monitoring training to students and teachers, and held annual congresses to share results.

East Valley Middle School
Spokane, WA
School received a grant to find easy ways to improve IAQ. Students researched IAQ issues and then shared their findings with students and staff. Students worked with administrators and maintenance staff to take remedial actions. The program has expanded to include eight schools with 10-20 students and a supervising teacher at each school.

Fulton Science Academy Middle School
Alpharetta, GA
Participated in Clean Air Campaign air quality education programs. Class measured AQ and reported a decrease in carbon dioxide levels on school grounds, perhaps due to a decrease in idling and increased carpooling.

Green Faith Schools
New Brunswick, NJ
Works directly with students and staff at schools to find easy ways to improve indoor air quality. Students conduct environmental audits at school and at home. As a result, schools have cleaned HVAC systems, switched to low-impact cleaning products, and taken other remedial actions.

The Harmony Project / Buist Academy for Advanced Studies
Charleston, SC
Sixth-grade class developed a model IAQ classroom, leading to the installation of new windows and carpet at the school.

Westview High School
Portland, OR
Students learned about AQ as part of a larger curriculum focusing on environmental heath. Learned about 12 IAQ topics and applied learning to a hypothetical middle school. Students then monitored their own school to see what issues/chemicals were present.

Programs that reported improvements in proxy air quality indicators:

Alternatives for Community and Environment
Roxbury, MA
Collaborates with schools and other programs to promote environmental justice and environmental quality improvement. A participating school mapped the local community and identified 15 bus and truck depots (including 1100 buses) within one mile of the school. Students worked with local authorities to push for the use of cleaner fuels and to move the bus depot.

CALS Early College High School
Los Angeles, CA
School's environmental club collected data on indoor air quality at the school, investigated the sources of identified problems, and researched what remedial actions could be taken. Students presented their findings to the school board. School administration distributed plants with air purifying qualities throughout the school. New air filters were also installed, and all ducts were inspected to make sure they were working properly.

City Academy
Salt Lake City, UT
High school students make biodiesel fuel for their school bus, with a goal of having all school field trips run on this alternative fuel. Students give presentations about biodiesel to other local schools.

City of Fort Worth, Environmental Management Department
Fort Worth, TX
Municipal program works with employees to change transportation-related behaviors. Offers financial incentives and comp time for employees who drive, walk, or van pool to work.

Darrington High School
Darrington, WA
Students monitored local AQ & found wood burning stoves causing significant problems. Students presented slide shows to local community groups and trained residents how to access online AQ monitoring information. Students also presented their work at an AQ conference sponsored by the EPA.

Ephrata High School
Ephrata, WA
Students researched particulates and glass fibers in ceiling tiles, and monitored indoor air quality. Shared findings with administrators and with other high school students in the state via teleconferencing. Project won an award from the EPA's *Tools for Schools* program in 2004.

Exeter High School
Exeter, NH
Students monitored car pooling and idling rates in the school drop-off area, which resulted in a no-idling policy and the installation of no-idling signs on school grounds.

Glace Bay High School
Glace Bay, Nova Scotia, Canada
High school students implemented the EPA's *Tools for Schools* program, and IAQ complaints dropped dramatically as result. Corrected AQ thermostat and ventilation problems, installed new air filters, removed carpet from school classrooms, and laundered drapes.

Greater Egleston Community High School
Roxbury, MA
Poor local air quality spurred students to organize community rallies, testify on air quality bills, and conduct letter writing campaigns. Resulted in the installation of a local air quality monitoring station, a change in fuels by city buses, and city-wide bus idling restrictions.

Healthy Living Foundation
Jupiter, FL
Middle school students participated in the Center for Health, Environment, and Justice's Green Flag Schools program. Environmental club met weekly for one year and monitored IAQ at the school.

High Meadows School
Roswell, GA
Students participated in air quality education outreach and awareness programs sponsored by the Clean Air Campaign.

Kimberly Hagen
North Middlesex, VT
Worked with a dozen schools in Vermont for five years to monitor local air quality and teach about AQ issues.

Long Beach Alliance for Children With Asthma
Long Beach, CA
"A-Teams" program trains mothers of children with asthma how to conduct community-based research and be effective public speakers. Program participants monitor AQ at two hot spots in the community over an eight-month period. Data is used to teach others about air quality issues and their relationship to asthma.

Rockwood Schools Center for Gifted Learning
Rockwood, MO
Fourth-grade students participated in a semester-long program "There's no zone like the ozone," focusing on AQ and stratospheric ozone loss. During the final six weeks, students take on a culminating project of their own choosing.

Sacred Heart School
Chicago, IL
Students study the sixth mass extinction with a particular focus on AQ. Students also conduct AQ experiments and measure local particulate and carbon dioxide levels.

South Carolina Department of Health and Environmental Control
Columbia, SC
Outreach program encourages public, in particular employees of the Bureau of Air Quality, to stay in for lunch or carpool. Program collects data online to track how much employees reduce driving.

Stonewall Tell Elementary
College Park, GA
Students participate in outreach programs sponsored by the Clean Air Campaign. Programs include a visit by the Clean Air Bear and distributing shoelaces and pencils to students who ride buses.

Sustainable Environment for Quality of Life
Charlotte, NC
Provided anti-idling signs to 495 schools in 11 counties. Also distributed anti-idling leaflets and bookmarks to more than 150,000 students and parents. Produced an educational video for all school districts.

Union 32 High School
Berlin, VT
AP biology students learned how to use AQ monitoring equipment. Measured outdoor air quality before buses came until the beginning of the school day, and then again at the end of the school day. Students reported findings to the school board, resulting in a change in bus idling practices.

Programs that took action to promote air quality improvement:

Air Quality Learning & Demonstration Center, Penn State Arboretum
University Park, PA
Air quality monitoring education lab that is open to the public for tours. Also provides education programs for school groups.

Appalachian Highlands Science Learning Center
Gatlinburg, TN
School groups visit the Center's "bio-garden" and learn about AQ monitoring activities. A curriculum developed for grades 7-12 uses plants to monitor ozone levels.

B'nai Shalom Day School
Greensboro, NC
Seventh-grade students conducted AQ-related science experiments in conjunction with a unit focusing on weather and climate. Collected data about car and bus idling.

Churchill High School
Eugene, OR
Participated in Center for Health and Environmental Justice's Green Flag Schools program. Worked with a local nonprofit and the school facilities manager to set up an IAQ monitoring program. Presented about the program to students and community.

City of Victoria, Environmental Services
Victoria, TX
Education program started in 2007 to address air quality issues. Program includes a no-idling initiative, AQ presentations at schools, and an AQ curriculum.

College Park High School
Pleasant Hill, CA
Air quality unit included in a high school AP environmental science class. Students test ozone outside their home and collect suspended particulate matter. Some students involved in native plant restoration projects.

El Diamante High School
Visalia, CA
As part of an AP environmental science class, students investigated air quality issues in local schools. They conducted simple testing and monitoring, and shared their findings with students and administration. Students have also presented their projects at an EPA conference.

Foulks Ranch Elementary
Elk Grove, CA
Participated in Project Citizen program. Students researched air pollution and light pollution, and then advocated for a "Value the Night Sky" city council resolution and new zoning restrictions.

Franklin High School
Franklin, TN
Students monitor for particulates at home, and analyze their samples in school science lab. Look under microscope. Assignments also focus on ozone monitoring and environmental policy and law.

Grant Community School
Salem, OR
Middle school students participated in a multi-year project focusing on school bus emissions and biodiesel. Gave presentations about biodiesel to six schools and requested to give presentation to local school board.

Main Street Middle School
Montpelier, VT
Students measured carbon dioxide levels throughout the school and then filled the building with plants.

Miami Coral Park Senior High School
Miami, FL
Students monitored AQ as part of an AP environmental science class. Discussed causes of asthma and which air pollutants are part of asthma attacks.

Mission Charter School
Phoenix, AZ
Curriculum unit for middle school students involving a timeline about natural resource and energy usage, and changes in local air quality over time. Students gathered AQ data using EPA monitoring websites.

NASA Goddard Space Flight Center
Greenbelt, MD
Education program uses earth observing satellite Aura to look at chemistry of atmosphere including air quality. Works with both public visitors to the center and with school groups.

North Carolina Department of Environment and Natural Resources, Air Quality Division
Fayetteville, NC
Outreach presentations about air quality to schools and churches. Presentations include storytelling, movies, simple experiments, games, and poster and essay contests. Also sponsor an air quality awareness week and distribute a monthly newsletter (including one-page each month about AQ) to 80,000 students. “Driving for Clean Air” program targets driver education teachers.

North Chatham School
Chapel Hill, NC
Elementary students learn about properties of air and air quality. Students watched *An Inconvenient Truth* and learned about monitoring statistics such as “parts per million.”

The Oakwood School
Greenville, NC
Taught AQ to seventth-grade students as part of a unit on climate and weather. Students studied gases in the atmosphere and ground level ozone, and took some AQ measurements.

Orange High School
Hillsboro, NC
AQ science incorporated into high school earth science class.

Philip G. Vroom School
Bayonne, NJ
Implemented “Air Pollution: What’s the Solution” curriculum at middle school.

The Rose Foundation
Oakland, CA
High school students monitor pollution in the local area, then contact local officials, write letters to industry, and participate in press conferences. Program was successful in getting a local industry to clean up some of its hazardous waste.

Seabrook Intermediate School
Seabrook, TX
Implemented "Air-O Dynamic" curriculum. Students conducted AQ laboratory experiments and created science fair projects focusing on AQ. Used photoionization device to detect organic compounds.

South Whidbey High School
Langley, WA
Independent study project by an environmental science student. Used AQ monitoring equipment from state and Western Washington University to gather data about IAQ and local AQ. Project has won an award from the EPA and has opened up dialogue about AQ within the school administration.

Wilson Creek High School
Wilson Creek, WA
Students researched high asthma rates in local community as part of the Youth Network for Healthy Communities program. Discovered possible link to illegal burning. Researched impacts of illegal burning and conducted a public awareness campaign.

Programs that provided information only:

Ashbrook High School
Gastonia, SC
Air quality science and issues are incorporated into a high school AP environmental science class.

La Cumbre Junior High School
Santa Barbara, CA
Students converted two cars to run on used vegetable oil. Teachers also included lessons about the carbon cycle and solar energy.

LF Blanton Elementary School
Carrollton, TX
Elementary students made posters about air quality and displayed them at a PTA meeting. In preparation for Earth Day, students handed out AQ awareness materials donated by Drive Clean Across Texas.

North Carolina Department of Environment and Natural Resources
Swannanoa, NC
Offers one-hour in-school programs including "Air Is All Around Us" (grades 2-4), "Driving Choices" (high school); "Climate Change" (7th grade and up); and "Where There Is Smoke" (high school).

Shelton High School
Shelton, WA
Students conducted a lichen/air quality study as part of the Youth Network for Healthy Communities program. Compared lichens close to and further from the road. Presented findings to other students who are part of YNHC.

Underwood Gifted and Talented Magnet Elementary
Raleigh, NC
Elementary students compared effects of air quality on different types of plants.

Appendix C: Descriptive Data

Relationship between specific program characteristics and improvements in physical and/or proxy air quality indicators

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
Who initiated program:				
Teacher	33 (61%)	12%	33%	46%
Not teacher	21(39%)	10%	38%	48%
Other school personnel	3 (6%)	33%	33%	67%
Not other school personnel	51(94%)	10%	35%	45%
Community organization	3 (6%)	0	67%	67%
Not community organization	51(94%)	12%	33%	45%
Advocacy organization	2 (4%)	0	50%	50%
Not advocacy organization	52(96%)	12%	35%	46%
Non-profit	7 (13%)	29%	57%	86%*
Not non-profit	47(87%)	9%	32%	40%
Corporation	n/a	n/a	n/a	n/a
Not corporation	54(100%)	11%	35%	46%
Industry association	n/a	n/a	n/a	n/a
Not industry association	54(100%)	11%	35%	46%
Government	13 (24%)	0	31%	31%
Not government	41(76%)	15%	37%	51%
Other	24(44%)	8%	33%	42%
Not other	30(56%)	13%	37%	50%
Part of a larger initiative	30 (56%)	17%	38%	54%
Not part of a larger initiative	24 (44%)	7%	33%	40%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical or proxy AQ indicators
Program worked with:				
School	41(76%)	7%	32%	39%
Local Community	2 (4%)	50%	50%	100%
Local community & school	10(19%)	20%	40%	60%
Other	1(2%)	0	100%	100%
Program participants				
Children only	41(76%)	7%	32%	39%
Adults only	3(6%)	0	100%	100%
Both children & adults	10(19%)	30%	30%[t]	60%[t]
Age/grade of participants				
Elementary	13(24%)	8%	39%	46%
Not elementary	41(76%)	12%	34%	46%
Middle school	22(41%)	18%	23%	41%
Not middle school	32(59%)	6%	44%	50%
High School	26(48%)	12%	39%	50%
Not high school	28(52%)	11%	32%	43%
College or university	1(2%)	0	0	0
Not college or university	53(98%)	11%	36%	47%
Children involved	50(93%)	12%	32%	44%
No children involved	4(7%)	0	75%[t]	75%
Other	8(15%)	13%	38%	50%
Not other	46(85%)	11%	35%	46%
Geographic area				
Urban	22(41%)	9%	41%	50%
Not urban	32(59%)	13%	31%	44%
Suburban	18(33%)	17%	39%	56%
Not suburban	36(67%)	8%	33%	42%
Rural	13(24%)	8%	31%	39%
Not rural	41(76%)	12%	37%	49%
Non-specific	2(4%)	0	50%	50%
Not non-specific	52(96%)	12%	35%	46%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
Race/ethnicity				
Black/African-American	15(28%)	8%	20%	27%
Not Black/African-American	39(72%)	13%	41%[t]	54%[t]
Hispanic/Latino	22(41%)	5%	32%	36%
Not Hispanic/Latino	32(59%)	16%	38%	43%
Asian	7(13%)	14%	43%	57%
Not Asian	47(87%)	11%	34%	45%
White	36(67%)	8%	32%	39%
Not white	18(33%)	17%	44%	41%
American Indian	4(7%)	0	25%	25%
Not American Indian	50(93%)	12%	36%	48%
Native Hawaiian	n/a	n/a	n/a	n/a
Not Native Hawaiian	54(100%)	11%	35%	46%
Other	5(9%)	0	40%	40%
Not other	49(91%)	12%	35%	47%
Non-specific	12(22%)	25%[t]	50%	75%*
Not non-specific	42(78%)	7%	31%	38%
Income level of participants				
Low income	26(48%)	8%	39%	46%
Not low income	28(52%)	14%	32%	46%
Middle income	23(43%)	9%	26%	35%
Not middle income	31(57%)	13%	42%	55%
High income	15(28%)	13%	27%	40%
Not high income	39(72%)	10%	39%	49%
Non-specific	9(17%)	22%	33%	56%
Not non-specific	45(83%)	9%	36%	44%
Other	1(2%)	100%**	0%	100%
Not other	53(98%)	9%	36%	45%
Is program still running?				
Yes	34(64%)	6%	32%	38%
No	19(34%)	21%[t]	42%	63%
Frequency of program				
Once a school year	11(22%)	9%	18%	27%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
Ongoing basis	32(64%)	16%	41%	56%
One time only	5(10%)	0	60%	60%
Once a school term	2(4%)	0	0	0
Other	12(22%)	17%	33%	50%
Not other	42(78%)	10%	36%	45%
Previous AQ program in area?				
Yes	14(28%)	7%	29%	36%
No	37(73%)	14%	38%	51%
Why was program started?				
Known Issue of poor AQ	28(52%)	7%	39%	46%
Not known Issue of poor AQ	26(48%)	15%	31%	46%
Suspicion of poor AQ	16(30%)	13%	38%	50%
Not suspicion of poor AQ	38(70%)	11%	34%	45%
Related to curriculum	23(43%)	9%	17%	26%
Not related to curriculum	31(57%)	13%	48%**	61%*
Personal interest	33(61%)	12%	24%	36%
Not personal interest	21(39%)	10%	52%*	62%^{t}
Links with asthma	32(41%)	14%	36%	50%
Not links with asthma	22(59%)	9%	34%	44%
Found AQ curriculum to try	18(33%)	11%	11%	22%
Not found AQ curriculum to try	36(67%)	11%	47%**	58%*
Specific funding	9(17%)	22%	33%	56%
Not specific funding	45(83%)	9%	36%	44%
Student concern	10(19%)	10%	20%	30%
Not student concern	44(82%)	11%	39%	50%
Other	20(37%)	10%	41%	35%
Not other	34(63%)	12%	25%	53%
For school programs				
n of schools that participated		r=-.07	r=.21	r=.14
Number of teachers involved		r=.70^{t}	r=-.14	r=-.04
How many years in operation		r=.03	r=.20	r=.21
How many students participated		r=-.18	r=-.20	r=-.22

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
Who led program				
Volunteer	0	n/a	n/a	n/a
Not volunteer	54(100%)	11%	35%	46%
School nurse	0	n/a	n/a	n/a
Not school nurse	54(100%)	11%	35%	46%
Caregivers/parents	1(2%)	100%**	0%	100%
Not caregivers/parents	53(98%)	9%	36%	45%
School teachers	43(80%)	14%	30%	44%
Not school teachers	11(20%)	0	55%	55%
Other school personnel	1(2%)	0	100%	100%
Not other school personnel	53(98%)	11%	34%	45%
Environmental specialist	13(24%)	15%	39%	54%
Not environmental specialist	41(76%)	10%	34%	44%
Children/students	0	n/a	n/a	n/a
Not children/students	54(100%)	11%	35%	46%
Other	17(32%)	12%	41%	53%
Not other	37(69%)	11%	32%	43%
Content addressed				
Science	43(80%)	12%	30%	42%
Not science	11(20%)	9%	55%	64%
Mathematics	20(37%)	10%	20%	30%
Not mathematics	34(63%)	12%	44%[t]	56%[t]
Social studies	17(32%)	6%	35%	41%
Not social studies	37(69%)	14%	35%	49%
Non-specific	2(4%)	50%[t]	50%	100%
Not non-specific	52(96%)	10%	35%	44%
Other	19(35%)	5%	16%	21%
Not other	35(65%)	14%	36%*	60%**
Was program stand alone?				
Part of regular subject	36(80%)	11%	31%	42%
Stand alone activity	3(7%)	33%	67%	100%
Both	6(13%)	0	33%	43%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical or proxy AQ indicators
Age of the program (in years)	Correlation *r*=	*r*=.03	*r*=.20	*r*=.21
Dose (hours participated)	Correlation *r*=	*r*=. 04	*r*=-.04	*r*=.-02
Dose (outlier dropped)	Correlation *r*=	*r*=.16	*r*=.10	*r*=.19
Funding				
Yes	27(50%)	19%[t]	37%	56%
No	27(50%)	4%	33%	37%
Source of funding				
School or institution budget	9(17%)	22%	33%	56%
Not school or institution budget	45(83%)	9%	36%	44%
Foundation	13(24%)	31%*	39%	69%[t]
Not foundation	41(76%)	5%	34%	39%
Corporation	9(17%)	11%	33%	44%
Not corporation	45(83%)	11%	36%	47%
Individual donor	4(7%)	0	50%	50%
Not individual donor	50(93%)	12%	34%	46%
Local fundraiser	3(6%)	0	33%	33%
Not local fundraiser	51(94%)	12%	35%	47%
Federal government	7(13%)	14%	57%	71%
Not federal government	47(87%)	11%	32%	43%
State government	5(15%)	13%	38%	50%
Not state government	46(85%)	11%	35%	46%
Local government	5(9%)	0	60%	60%
Not local government	49(91%)	12%	33%	45%
Other	19(35%)	16%	37%	53%
Not other	35(65%)	9%	34%	43%
Duration of funding				
Not funded	32(59%)	6%	34%	41%
Less than 6 months	3(6%)	0	33%	33%
6 months to less than a year	6(11%)	33%	33%	67%
1-3 years	4(7%)	50%*	0	50%
More than 3 years	9(17%)	0	56%	56%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
Total funding				
None	27(50%)	4%	33%	37%
Less than $10,000	12(22%)	17%	25%	42%
More than $10,000	15(28%)	20%	27%	67%
Controlling Independent Variable A (CVA): Total support	Correlation *r*=	*r*=.38**	*r*=-.05	*r*=.20
CVA1 School (supp/v supp)	48(89%)	13%	38%	50%
CVA2 Parents (supp/v supp)	41(76%)	15%	39%	54%[t]
CVA3 Businesses (supp/v supp)	24(44%)	21%*	33%	54%
CVA4 Government (supp/v supp)	35(65%)	14%	29%	43%
CVA5 Funding?	27(50%)	19%[t]	37%	56%
CVA6 In-kind support?	41(76%)	15%	32%	46%
CVA7 Outside collaboration?	37(69%)	14%	32%	46%
CVA 1-7 Total support (CVAYN-TOT; range 1-7)	4.7 = mean			
Low support(1-3)	13(24%)	0%	46%	46%
Medium support(4-5)	24(44%)	8%	33%	42%
High support (6-7)	17(32%)	24%	29%	53%
CVA 1-7 Total support (CVAYN-TOT; sum all 7)	Correlation *r*=	*r*=.38**	*r*=-.19	*r*=.20
Controlling Independent Variable B (CVB): Total funding				
CVB1 Total funding				
Any funding	27(50%)	19%[t]	59%	56%
No funding	27(50%)	4%	44%	37%
CVBTOT total funding (CVBTOT)	Correlation *r*=	*r*=.21	*r*=.11	*r*=.24[t]
Controlling Independent Variable C (CVC): PBL/EE experience/readiness				
CVC1 PBL/EE experience				
Yes (somewhat or lots)	42(78%)	12%	33%	45%
No (not at all)	12(22%)	8%	42%	50%
CVC2 School or organization included PBL/EE before?				
Yes (somewhat or lots)	41(76%)	15%	32%	46%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
No (not at all)	13(24%)	0	46%	46%
CVC3 PBL/EE training?				
Yes (somewhat or lots)	29(54%)	10%	28%	38%
No (not at all)	25(46%)	12%	44%	56%
CVC 1-3 Total	Correlation *r*=	*r*=.06	*r*=-.15	*r*=-.10
Controlling Independent Variable D (CVD): Program dose				
CVD1 Average participant hours	Correlation *r*=	*r*=.16	*r*=.10	*r*=.19 [t]
TOTAL PBLNESS (sum of all 18 items)	Correlation *r*=	*r*=.20	*r*=.29*	*r*=.40**
Measurements exceed EPA recommendations?				
Yes	14(26%)	29%*	36%	64%
No, don't know, or didn't measure	40(74%)	5%	35%	40%
Data collected by				
Students	35(65%)	14%	37%	37%
Not students	19(35%)	5%	32%	51%
Teachers/program leaders	10(19%)	30%*	60%[t]	90%**
Not teachers/program leaders	44(82%)	7%	30%	36%
Outside expert	10(19%)	10%	60%[t]	70%[t]
Not outside expert	44(82%)	11%	30%	41%
Other	9(17%)	11%	44%	56%
Not other	45(83%)	11%	33%	44%
Geographic scale measured				
1 room in 1 building	7(13%)	29%	14%	43%
Not 1 room in 1 building	47(87)	9%	38%	47%
Multiple rooms in 1 building	18(33%)	17%	33%	50%
Not multiple rooms in 1 building	36(67%)	8%	36%	44%
Multiple buildings	7(13%)	43%**	14%	57%
Not multiple buildings	47(87)	6%	38%	45%
The immediate vicinity around one or a few buildings	21(39%)	14%	29%	43%

	n (%) of programs with this characteristic	Improvement in physical AQ indicators	Improvement in proxy AQ indicators	Improvement in physical <u>or</u> proxy AQ indicators
Not the immediate vicinity around one or a few buildings	33(61%)	9%	39%	49%
A community or neighborhood	10(19%)	10%	50%	60%
Not a community or neighborhood	44(82%)	11%	32%	43%
Town/city-wide	9(17%)	11%	67%*	78%*
Not town/city-wide	45(83%)	11%	39%	40%
Regional	5(9%)	0	60%	60%
Not regional	49(91%)	12%	33%	45%
National	1(2%)	0	100%	100%
Not national	53(98%)	11%	43%	45%
International	2(4%)	0	50%	46%
Not international	52(96%)	12%	35%	50%
Program activities				
AQ readings	49(91%)	12%	37%	49%
Not AQ readings	5(9%)	0	20%	20%
Public awareness or education	49(91%)	12%	39%[t]	51%*
Not public awareness or educ.	5(9%)	0	0	0
Scientific AQ experiments	43(80%)	9%	33%	42%
Not scientific AQ experiments	11(20%)	18%	46%	64%
Videos or movies	42(78%)	10%	38%	48%
Not videos or movies	12(22%)	17%	25%	42%
AQ data collection	37(69%)	11%	43%[t]	54%[t]
Not AQ data collection	17(32%)	12%	18%	29%
Guest lectures	36(67%)	17%[t]	36%	53%
Not guest lectures	18(33%)	0	33%	33%
AQ measurement	36(67%)	14%	39%	53%
Not AQ measurement	18(33%)	6%	28%	33%
Public action or policy	34(63%)	12%	50%**	62%**
Not public action or policy	20(37%)	10%	10%	20%
Field trips	32(59%)	13%	38%	50%
Not field trips	22(41%)	9%	32%	41%
Environmental policy study	30(56%)	7%	40%	67%
Not environmental policy study	24(44%)	17%	29%	66%
Environmental restoration	16(30%)	13%	38%	50%
Not environmental restoration	38(70%)	11%	34%	45%

	***n* (%) of programs with this characteristic**	**Improvement in physical AQ indicators**	**Improvement in proxy AQ indicators**	**Improvement in physical <u>or</u> proxy AQ indicators**
Other	12(22%)	8%	33%	42%
Not other	42(78%)	12%	36%	48%
Any data available?				
Yes	24(44%)	17%	50%*	67%**
No or don't know	30(56%)	7%	23%	30%
Data format				
Paper records	7(13%)	43%**	57%	100%**
Not paper records	47(87%)	6%	42%	38%
Computer record or spreadsheet	11(20%)	18%	46%	64%
Not computer record/spreadsheet	43(80%)	9%	33%	42%
Other	12(22%)	25%[t]	50%	75%*
Not other	42(78%)	7%	31%	38%
If your program did not follow-up test, what was the reason?				
Other	20(37%)	0	30%	30%
Not other	34(63%)	17%*	38%	56%[t]
Not part of program goals	19(35%)	0	21%	21%
Not not part of program goals	35(65%)	17%[t]	43%	60%**
Lack of time	15(28%)	7%	40%	47%
Not lack of time	38(72%)	13%	33%	46%
Difficulty of measurement	4(7%)	25%	25%	50%
Not difficulty of measurement	50(93%)	10%	36%	46%
Lack of funding	3(6%)	0	33%	33%
Not lack of funding	51(94%)	12%	35%	37%
Lack of technical expertise	3(6%)	0	67%	67%
Not lack of technical expertise	51(94%)	12%	33%	45%
Don't know	2(4%)	0	50%	50%
Not don't know	52(96%)	12%	35%	46%
Evaluation of program?				
Yes	13(24%)	39%***	23%	62%
No or don't know	41(76%)	2%	39%	42%

	***n* (%) of programs with this characteristic**	**Improvement in physical AQ indicators**	**Improvement in proxy AQ indicators**	**Improvement in physical <u>or</u> proxy AQ indicators**
Internal or external evaluation?				
Not done/don't know	41(76%)	2%	39%	42%
Internally	10(19%)	30%	30%	60%
Externally	1(2%)	0	0	0
Combination of internal & external	2(4%)	100%***	0	100%
Program evaluation components				
Quality of implementation	8(15%)	50%***	38%	88%*
Not quality of implementation	46(85%)	4%	35%	39%
Awareness outcomes	8(15%)	63%***	0	63%
Not awareness outcomes	46(85%)	2%	41%*	44%
Behavioral outcomes	6(11%)	33%^{t}	33%	67%
Not behavioral outcomes	48(89%)	8%	35%	44%
Environmental quality outcomes	6(11%)	50%**	33%	83%^{t}
Not environmental qual. outcomes	48(89%)	6%	35%	42%
Content learning outcomes	5(9%)	20%	20%	40%
Not content learning outcomes	49(91%)	10%	37%	47%
Other	3(6%)	33%	0	33%
Not other	51(94%)	10%	37%	47%

Appendix D: Survey Instrument

Quantifying a Relationship Between Place-based Learning and Environmental Quality
A survey of educational programs
Brian Johnson, Michael Duffin, Michael Murphy—Dec. 1, 2007

Researchers from Shelburne Farms, PEER Associates, and Antioch University New England are asking you to participate in a survey about air quality education programs. The researchers want to know what educational activities have been used to teach about air quality and any evaluation of these programs. We are contacting you because we believe you know a lot about one such program. We will use the results of the survey to strengthen the fields of place-based and environmental education through reports to the Environmental Protection Agency (the funder of this research), academic journals, and other appropriate venues.

Taking part is voluntary.
Your participation in this survey is completely voluntary. If you do participate in the survey, you may choose to skip any question or end the questionnaire at any time, but we ask you to answer as many questions as you can. Your responses are confidential—no identifying information will be shared with anyone outside the research team.

Thank you.
Our survey is done over the phone at a time that is convenient to you. It takes about 45 minutes and can be done in one or two sittings, whatever you prefer. In consideration for your time, we will mail you a $25 gift certificate of your choice for either books, a magazine, food or carbon offsetting.

If you have questions about the survey, please contact:

Brian Johnson	Sharon Plumb	Michael Duffin
brian_johnson@antiochne.edu	sharon@peerassociates.net	michael@peerassociates.net

If you have any questions regarding your rights as a research participant, please contact:
George Tremblay
Director of Research
Antioch University New England
40 Avon Street
Keene, NH 03134

Introduction

This survey is part of the two-year project, "Quantifying a Relationship Between Place-based Learning and Environmental Quality." Many place-based learning and environmental education projects involve students in activities that relate directly or indirectly to efforts to improve environmental quality. However, research-based evidence exploring the link between place-based learning and direct measures of environmental quality has not been synthesized to any significant extent. This project aims to review the evidence for a direct connection between place-based learning and improvements in environmental quality by collecting data through this survey from place-based and environmental education programs that focus on air quality.

"Environmental quality" was narrowed for this study to "air quality" for several reasons. First, comparing programs addressing a variety of environmental quality issues would complicate our ability to analyze the data effectively. Second, air quality was chosen as this study's focus because of its links to asthma and children's health and because of the increasing number of programs with a focus on improving *indoor* air quality. We surmised that the indoor environment would represent a manageable scale for education programs to engage in environmental quality investigation and problem solving.

The research project is funded by the U.S. Environmental Protection Agency's Office of Environmental Education. Project partners are the National Park Service's Conservation Study Institute and its Center for Place-based Learning and Community Engagement, Shelburne Farms, PEER Associates, Adopt-A-Watershed, Harvard Medical School, Massachusetts General Hospital, and Antioch University New England.

The survey will take approximately 45 minutes. We will start by asking you background information questions about your air quality education program. Next, we will ask questions about the design of your air quality education program and the activities that are included in the program. Finally, we will ask questions about program outcomes and evaluation. Please keep in mind that we are gathering information from a variety of types and styles of air quality education programs. Some of the questions we will ask you will seem less relevant or applicable than others. This is by no means a judgment of the important work you are doing. It simply reflects the fact that we need to ask a wide range of questions in order to understand the full spectrum of air quality education work taking place around the country.

Do you have any questions before we begin?

Section One: Interviewee Information

SM1/DQ1: Interview date: _____

SM2/DQ2: Interviewer: _____

SM3/DQ3: Interviewee name, organization, role: _____

SM4/DQ4: Interviewee phone number: _____

SM5/DQ5: Interviewee address:

SM6/DQ6: Interviewee email: _____

SM7/DQ7: Confirmation of informed consent (including responding to all questions/concerns)?
- Yes
- No

SM7b/DQ8: Interview start time: _____

Section Two: Program Background

I'd like to start by asking you some questions about the background of your program.

SM8a/DQ9: Please briefly describe the air quality program that you have been involved with. Where did it take place and what did you do?
- *Open-ended question*

SM8b/DQ10: Who initiated the program? Was the organization or individual a:
- Teacher
- Other school personnel
- Community organization
- Advocacy organization
- Other nonprofit
- Corporation
- Industry association
- Government
- Other (specify)

SM9/DQ11: Was your program part of a larger initiative (e.g. national or multi-site program)?
- Yes
- No, just at this school/site

SM10/DQ12: What was the name of the larger initiative your program was part of?

Please specify

SM11/DQ13: Which of the following best describes the population your education program worked with?

School
Local community
Both school and local community
Other (specify)

SM12/DQ14: Were your program participants children, adults, or both?

Children only
Adults only
Both children and adults
No specific target

SM13/DQ15: What grade(s) or age(s) were the children that participated in your program? Include all that apply.

Elementary (grades K-5)
Middle school (grades 6-8)
High school (grades 9-12)
College
Other (specify)
No children were involved

SM14/DQ16: Which of the following best describes the geographic area of your program location?

Urban
Rural
Suburban
No specific target

SM15/DQ17: Please describe the race or ethnicity of your program participants. (Include all that apply.)

Black/African-American
Hispanic/Latino
Asian
White
American Indian/Alaskan Native
Native Hawaiian
Other
No specific target

SM16/DQ18: Which of the following best describes the socio-economic background of your program participants?

Low income
Middle income
High income
No specific target

SM17/DQ19: How many years has your program been in operation, or (for programs no longer operating) how long did your program run?

_____ (# of years)

SM18/DQ20: Is your program still running?

Yes
No

SM19/DQ21: If your program is no longer operating, why was it discontinued?

Funding
Issues resolved or in the process of being resolved
Lack of community support
Lack of institutional support
Lack of student interest
Leader no longer present/available
Time
Other (please specify)

SM20/DQ22: Which of the following best describes the duration of your program (when in operation, if discontinued)?

The program was implemented one time only.
The program was implemented once every school term.
The program was implemented once every school year.
The program was implemented on an ongoing basis.
Other (please specify)

SM21/DQ23: To your knowledge, had anyone previously run another air quality education program at your school or another school in the district?

Yes
No

SM22/DQ24: Do you have contact information for the previously run air quality education program?

Yes, here is their contact information: _____
No

SM23/DQ25: Why was your air quality education program started? (Include all that apply.)

- Poor air quality is a known issue in area
- Suspicion that air quality may be a problem
- Relates well to curriculum requirements
- Personal interest/curiosity related to air quality science
- Links with asthma and children
- Found high-quality air quality curriculum and wanted to try
- Funding provided specifically for air quality program
- Student concern about air quality or asthma/health in friends/family
- Other (please specify)

SM24/DQ26: To your knowledge, before your program had anything been done in your community previously to improve air quality (not necessarily education)?

- Yes
- No

SM25/CVA1: How supportive of your program was your school or organization leadership?

- Very supportive
- Somewhat supportive
- Passive or not at all supportive
- Actively worked against the program
- Don't know

SM26/CVA2: How supportive of your program were parents and families of participants?

- Very supportive
- Somewhat supportive
- Passive or not at all supportive
- Actively worked against the program
- Don't know

SM27/CVA3: How supportive of your program were local businesses or industry?

- Very supportive
- Somewhat supportive
- Passive or not at all supportive
- Actively worked against the program
- Don't know

SM28/CVA4: How supportive of your program were local, state and/or federal government officials or agencies?

Very supportive
Somewhat supportive
Passive or not at all supportive
Actively worked against the program
Don't know

SM29a/DQ27: What do you see as the primary purpose of environmental education?

Open-ended question

SM29b/DQ28: How do you see your program relating to that purpose?

Open-ended question

SM30a/CVC1: To what extent had the teachers or program facilitators taught environmental education or place-based education before this program?

Not at all – This was their first environmental or place-based program.
Somewhat – They had occasionally used environmental or place-based education.
Lots – Environmental and/or place-based education is a regular component of their teaching practice.

SM30b/CVC2: To what extent had your school or organization implemented environmental education or place-based education before this program?

Not at all – This was the first environmental or place-based program.
Somewhat – Environmental or place-based education has been used occasionally.
Lots – Environmental and/or place-based education is a regular component of the school or organization.

SM31a/CVC3: Had you ever received any environmental education or place-based education training prior to implementing this program?

Yes (please describe)
No

SM31b/DQ29: How many years have you worked as a teacher or educator?

_____ (respondent-specified number)

SM32/DQ30: For school programs, how many schools participated in the program?

_____ (respondent-specified total number of participating schools)

SM33/DQ31: For school programs, how many teachers were involved in the planning and delivery of the program?

_____ (respondent-specified total number of teachers involved)

SM34/DQ32: For school programs, how many students participated in the program?

_____ (respondent-specified total number of students)

SM35/DQ33: For non-school-based programs, which of the following best describes the level of participation in your program?

A few individuals
One organization or community
Multiple organizations or communities
Town- or city-wide
State or regional
National
International
_____ Other estimated number of individuals

SM36/CVD1: About how many hours did the typical participant participate in the program and related activities (for example, homework) over the entire course or program?

_____ (respondent estimate of 'dose')

SM37/DQ34: Who was responsible for facilitating or teaching your program? Include all that apply.

Volunteer
School nurse
Parents/caregivers
School teacher
Other school personnel
Environmental specialist
Children/students in general
Other (please specify)

SM38/DQ35: For school-based programs, which content areas were specifically addressed?

Science
Mathematics
Social Studies
Other (please specify)
None

SM39/DQ36: For school-based programs, was the program part of a regular subject or a stand-alone activity not part of school coursework?

Part of a regular subject
Stand-alone activity

SM40/DQ37: For stand-alone activities, how was the program integrated into the school context?

Optional workshop
Community service
Extracurricular club
After-school program
Other (please specify)

SM41/CVA5: Did your program receive any funding to support its implementation?

Yes
No (skip to SM45/CVA6)
Don't know (skip to SM45/CVA6)

SM42/DQ38: From which source or sources did you receive the funding for your program? (Include all that apply.)

Existing school or institution budget
Foundation
Corporation
Individual donor
Local fundraiser
Federal government
State government
Local government
Other (please specify)

SM43/DQ39: For how long was the funding you received designated to support your program?

Less than 6 months
6 months – less than 1 year
1- 3 years
More than 3 years

SM44/CVB1: How much *total* funding support did your program receive?

Less than $1,000
$1,000 - $5,000
$5,001 - $10,000
$10,001 - $50,000
$50,001 - $100,000
More than $100,000

SM45/CVA6: Did your program receive any in-kind support, for example volunteer time, meeting space at no cost, etc.?

Yes
No (skip to Q47)

SM46/DQ40: What kinds of in-kind support did you receive?
Open-ended question

SM47/CVA7: Did you collaborate with other individuals or groups to run your program?
Yes
No (skip to SM50/PIV1)

SM48/DQ41: With whom did you collaborate? (Include all that apply.)
Schools
Local government agency
State government agency
Federal government agency
Community groups
Youth groups (such as Scouts)
Advocacy groups
Other nonprofits
Families
Industry/corporations
Higher education institutions
Other (please specify)

SM49/DQ42: In what ways did you collaborate? (Include all that apply.)
Sharing resources or materials
Joint program planning
Technical assistance
Collaboration on policy action
Fundraising
Other (please specify)

Section Three: Program Design and Implementation

Now, I'd like to ask you some questions about the design and implementation of your program. When answering these questions, please think about the program that was provided during the most recent school year or year of implementation.

I will read a list of program attributes or qualities. Please tell me to what degree your program included each of the attributes. Please choose either "not at all," "somewhat," or "strong." Keep in mind that these questions are not meant to reflect any sort of "ideal" program. The questions simply reflect many of the qualities and practices common in today's place-based and environmental education programs. We are trying to determine which qualities and practices are most commonly used and how they may or may not affect program outcomes.

SM50/PIV1: Program used the local environment and/or community as a context for learning. In other words, students learned about real local issues perhaps by including field trips or through visits from local people to the classroom.

Not at all
Somewhat
Strong

SM51/PIV2: Program was experiential or hands-on.

Not at all
Somewhat
Strong

SM52/PIV3: Program contributed to authentic school or community needs. In other words, students took part in projects that helped address real school or community issues.

Not at all
Somewhat
Strong

SM53/PIV4: Program promoted attachment to and love of local community or place.

Not at all
Somewhat
Strong

SM54/PIV5: Program promoted an understanding of relevant issues on a larger scale, for example regional, state, national or global levels.

Not at all
Somewhat
Strong

SM55/PIV6: Program utilized existing or created strong local partnerships.

Not at all
Somewhat
Strong

SM56/PIV7: Program was project-based. In other words, the program was designed to answer a question or solve a problem, and the program generally reflected the types of learning and work people do in the everyday world outside the classroom. (Definition courtesy of the Buck Institute for Education and Boise State University.)

Not at all
Somewhat
Strong

SM57/PIV8: Program was supported by school/organization leadership.

Not at all
Somewhat
Strong

SM58/PIV9: Program was supported by local community.

Not at all
Somewhat
Strong

SM59/PIV10: Program was tailored to the learning styles of individual students.

Not at all
Somewhat
Strong

SM60/PIV11: Program content was interdisciplinary.

Not at all
Somewhat
Strong

SM61/PIV12: Program was personally relevant to learners. In other words, the program addressed concerns and issues in ways that made them personal or relevant to students' lives.

Not at all
Somewhat
Strong

SM62/PIV13: Program fostered collaboration between educator/facilitator and local community.

Not at all
Somewhat
Strong

SM63/PIV14: Program required students to work both in groups and individually.

Not at all
Somewhat
Strong

SM64/PIV15: Program included structured reflection by students about their learning process.

Not at all
Somewhat
Strong

SM65/PIV16: Program was initiated by students.

Not at all
Somewhat
Strong

SM66/PIV17: Program was driven or led, but not necessarily initiated, by students.

Not at all
Somewhat
Strong

SM67/PIV18: Program included a service-learning component. In other words, students contributed a positive service to the school or community that also actively supported the goals of their academic learning.

Not at all
Somewhat
Strong

Now we'll move onto some additional questions about the design and implementation of your program.

SM68/DQ43: Which of the following best describes the types of curricular materials you used for your program?

Newly developed for use in this program
Existing materials, not adapted (please specify)
Existing materials, adapted (please specify)
Used a combination of existing materials and newly developed materials (please specify)
Did not use any materials

SM69/DQ44: Which air quality issues did your program address? (Include all that apply.)

Indoor air quality
Local outdoor air quality
Outdoor air quality (general)
School bus/car idling
Other (please specify)

SM70/DQ45: I will now read a list of program activities. Please tell me whether each of the activities was included in your program. (Include all that apply.)

Readings about air quality
Science experiments related to air quality
Actual AQ measurement
Collection of data related to air quality (i.e. bus idling or ridership rates)
Public awareness or education
Environmental policy study

Public action or advocacy
Environmental restoration (i.e. tree planting)
Videos or movies
Field trips
Guest lectures
Other (please specify)

SM71/DV1A1: Did your program collect data about or measure air quality (for example, carbon dioxide or particulates) or air quality-related behaviors (for example, school bus idling, health issues, or awareness)?
Yes
No (skip to SM74)

SM72/DQ46: Who collected the data in your program?
Students/participants
Teachers/program leaders
Outside expert
Other (please specify)

SM73/DQ47: To which geographic scale did your measurements most directly apply?
One room in a single building
Many rooms in a single building
Multiple buildings
The immediate vicinity around one or a few buildings
A community or neighborhood
Town- or city-wide
Regional
National
International

Section Four: Air Quality Measurement Activities

Now I'd like to ask you questions about the air quality measurements that you may have taken.

SM74: Which of following air quality measurements did you take?
DV1B1: carbon dioxide
DV1B2: air flow
DV1B3: particulates
DV1B4: temperature
DV1B5: humidity
DV1B6: odors
Don't know

SM75: Did any of the measurements exceed EPA recommendations for indoor/outdoor air quality?

DV1C1: carbon dioxide
DV1C2: air flow
DV1C3: particulates
DV1C4: temperature
DV1C5: humidity
DV1C6: odors
Don't know

SM76: Did your program measure the presence of:

DV1B7: animals or insects
DV1B8: damp or mold

SM77/DV1B9: Did your program measure any other air quality indicators?

Yes (please specify)
No
Don't know

In addition to specific air quality measurements such as carbon dioxide, we are also interested in whether your program tracked or measured air-quality-related behaviors or actions. I'll now ask you whether your program measured any of these behaviors or actions.

SM78: Did your program measure any of the following:

DV1D1: car or bus idling practices
DV1D2: bus ridership rates
DV1D3: car pooling rates
DV1D4: walking or bicycle riding rates
DV1D5: air-quality related health symptoms or complaints (e.g. asthma, sore throat, itchy eyes)?
DV1D6: *awareness* of air quality issues
DV1D7: measure or track school absences, or obtain this data from school records

SM79/DV1D8: Did your program measure any other air-quality-related behaviors?

Yes (please specify)
No
Don't know

SM80/DQ48: Is any of your data available for further analysis as part of this study?

Yes
No (skip to SM83)
Don't know (skip to SM83)

SM81/DQ49: In what format is your data available?

As paper records
In a computer spreadsheet or database
In another format (please specify)

SM82/DQ50: Whom would we need to contact to obtain this data?

Section Five: Program Impacts

Now I'd like to ask you about any results or outcomes that occurred as a result of your air quality program.

SM83: What did you do with the findings of your program activities? Did you… (Include all that apply.)

83a/DV2A1: Do analysis as part of class curriculum
83b/DV2A2: Report your findings to a governing body (e.g. school board, town council)
83c/DV2A3: Begin a public awareness or education campaign
83d/DV2A4: Contact media outlets
83e/DV2A5: Push for policy implementation or strengthening
83f/DV2A6: Other (please specify)
83g/DQ51: No actions known to be taken

SM84: Did any of the following *actions* result from your findings? (Include all that apply.)

84a/DV2B1: Policy implemented or strengthened (e.g. IAQ, anti-idling)
84b/DV2B2: Air quality control measures implemented
84c/DV2B3: Further study of issue undertaken
84d/DV2B4: Media coverage of problem/issue
84e/DV2B5: Public awareness of problem/issue raised
84f/DV2B6: Individual behavior changes
84g/DV2B7: Other actions (please specify)
84h/DQ52: No actions known to result

SM85/DQ53: Did you measure air quality or related behaviors after action had been taken? In other words, was there any kind of 'post test' to assess the impact of your actions, through measurement of environmental quality or related behaviors?

Yes
No (skip to SM116/DQ69)
Don't know (skip to SM116/DQ69)

For each air quality indicator or related behavior measured *after* action had been taken, what were the results of the findings? (Only ask about categories that were confirmed measured earlier in survey.)

SM86/DV3A1: Carbon dioxide

Improved
Worsened
No change
Don't know

SM87/DQ54: To what do you attribute the change?

Open-ended question

SM88/DV3A2: Air flow

Improved
Worsened
No change
Don't know

SM89/DQ55: To what do you attribute the change?

Open-ended question

SM90/DV3A3: Particulates

Improved
Worsened
No change
Don't know

SM91/DQ56: To what do you attribute the change?

Open-ended question

SM92/DV3A4: Temperature

Improved
Worsened
No change
Don't know

SM93/DQ57: To what do you attribute the change?

Open-ended question

SM94/DV3A5: Relative humidity

Improved
Worsened
No change
Don't know

SM95/DQ58: To what do you attribute the change?
Open-ended question

SM96/DV3A6: Odors
Improved
Worsened
No change
Don't know

SM97/DQ59: To what do you attribute the change?
Open-ended question

SM98/DV3A7: Animals/insects
Improved
Worsened
No change
Don't know

SM99/DQ60: To what do you attribute the change?
Open-ended question

SM100/DV3A8: Damp/mold
Improved
Worsened
No change
Don't know

SM101/DQ61: To what do you attribute the change?
Open-ended question

SM102/DV2C1: Car or bus idling
Improved
Worsened
No change
Don't know

SM103/DQ62: To what do you attribute the change?
Open-ended question

SM104/DV2C2: Bus ridership

Improved
Worsened
No change
Don't know

SM105/DQ63: To what do you attribute the change?

Open-ended question

SM106/DV2C3: Car pooling

Improved
Worsened
No change
Don't know

SAM107/DQ64: To what do you attribute the change?

Open-ended question

SM108/DV2C4: Walking/bicycle riding

Improved
Worsened
No change
Don't know

SM109/DQ65: To what do you attribute the change?

Open-ended question

SM110/DV2C5: Symptoms/complaints (asthma, sore throat, itchy eyes) or other health issues

Improved
Worsened
No change
Don't know

SM111/DQ66: To what do you attribute the change?

Open-ended question

SM112/DV2C6: Awareness of air quality issues

Improved
Worsened
No change
Don't know

SM113/DQ67: To what do you attribute the change?

Open-ended question

SM114/DV2C7: School absences

Improved
Worsened
No change
Don't know

SM115/DQ68: To what do you attribute the change?

Open-ended question

SM116/DQ69: If your program did not measure air quality or behavior outcomes after action had been taken (e.g. follow-up testing), what was the reason? (Include all that apply.)

Lack of technical expertise
Lack of time
Lack of funding
Difficulty of measurement
Not part of program goals
Don't know
Other (please specify)

SM117/DV3B1: Overall, how would you summarize the impact of your air quality education program on air quality? *As a result of this program*, air quality…

Improved a lot
Improved a little
Did not change
Got worse
Don't know

SM118/DQ70: What do you think were the key factors that influenced this outcome?

Open-ended question

SM119/DQ71: Thinking back over your project, are there any types of outcome data you wish you had (for example, air quality data or knowledge/behavior data)?

Open-ended question

SM120/DQ72: Was there an evaluation of your program?

Yes
No (skip to SM124/DQ76)
Don't know (skip to SM124/DQ76)

SM121/DQ73: Was the evaluation done internally by program staff or externally by outside evaluators?

Internally
Externally
Combination of internally and externally
Don't know

SM122/DQ74: Which of the following did the program evaluation measure? (Include all that apply.)

Quality of implementation
Content learning outcomes
Awareness outcomes
Behavioral outcomes
Environmental quality outcomes
Other evaluation measures

SM123/DQ75: How would you summarize the findings of your program evaluation?

Open-ended question

Section Six: Conclusion

SM124/DQ76: Overall, what do you personally think were the most important results of your program?

Open-ended question

SM125/DQ77: Overall, did anything else happen as a result of your program that you didn't intend or expect from the outset? In other words, were there any unintended outcomes or consequences associated with your program?

Open-ended question

SM126/DQ78: Are you available for follow up communication to clarify or expand on your responses if necessary?

Yes
No

SM127/DQ79: Do you know of any other teachers or educators that run air quality education programs and who would be good for us to interview for this study? (If yes, record contact name and information.)

Open-ended question

SM128/DQ80: That finishes the questions I have for you today. Do you have any questions you would like to ask or share with me, or is there anything else you think I should know about your program that I didn't ask you?

SM129/DQ81: I want to thank you for taking the time to complete this survey. As a token of our appreciation, we would like to give you one of the following. Which option would you prefer?

A one-year subscription to *Green Teacher* magazine (sent to physical address)

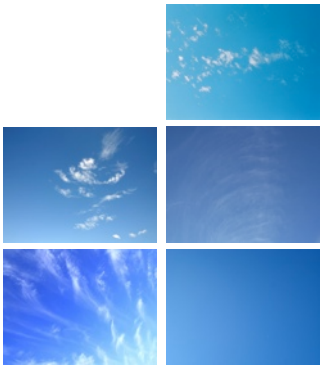
A $25 gift certificate to Powell's bookstore (orders can be made online) (sent to email address)

Two tons of carbon offsets—enough to offset the emissions of a medium-size car for four months! (sent to physical address)

A $25 gift certificate to Starbucks (sent to physical address)

SM130/DQ82: We will send your gift certificate, voucher or subscription to the address or email address you gave at the beginning of the interview. Is that still the best address? (If not, record best address for sending voucher.)

SM131/DQ83: Interview end time: _____



Appendix E: References

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Appendix F: Photo Credits

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